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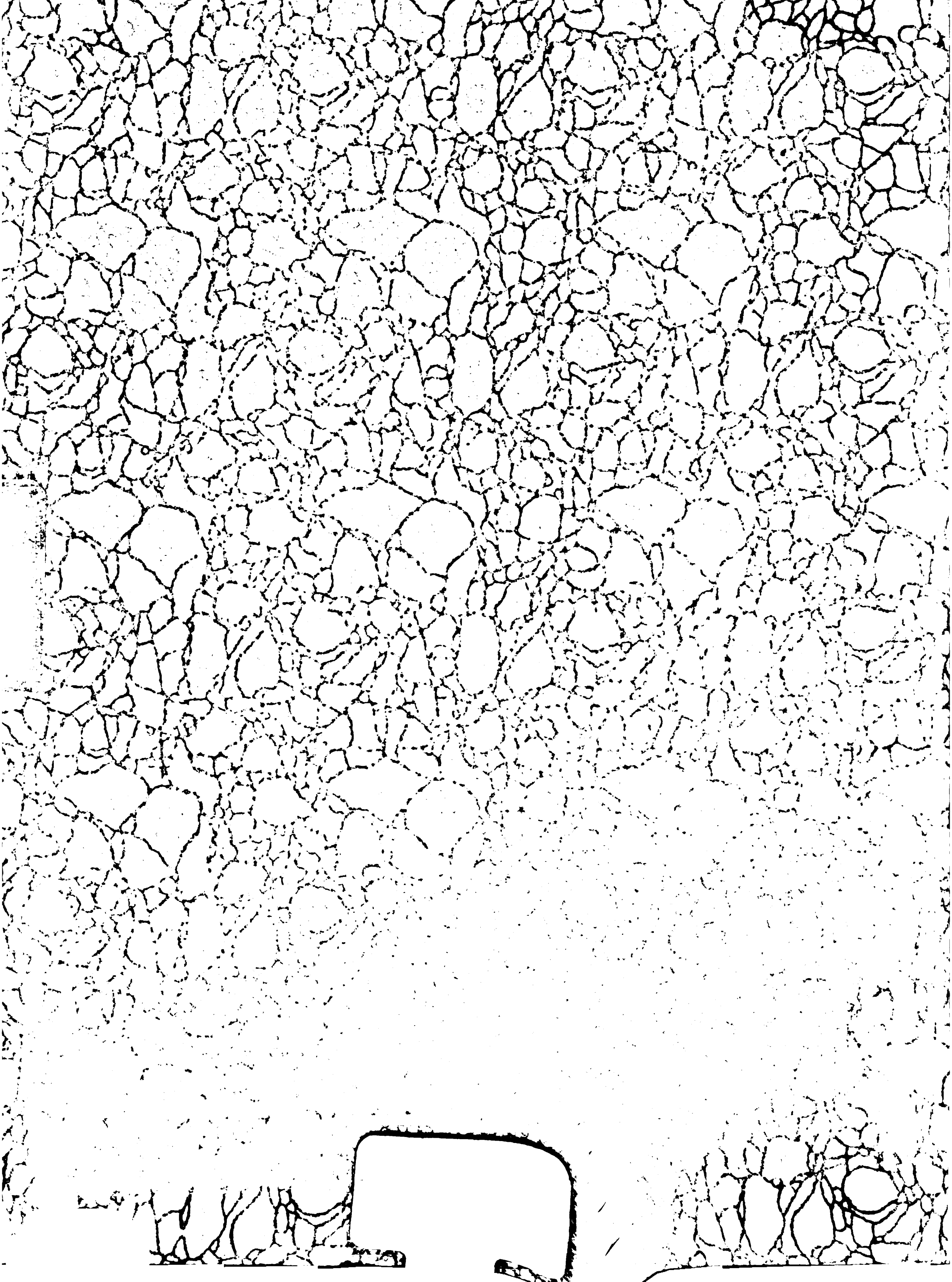

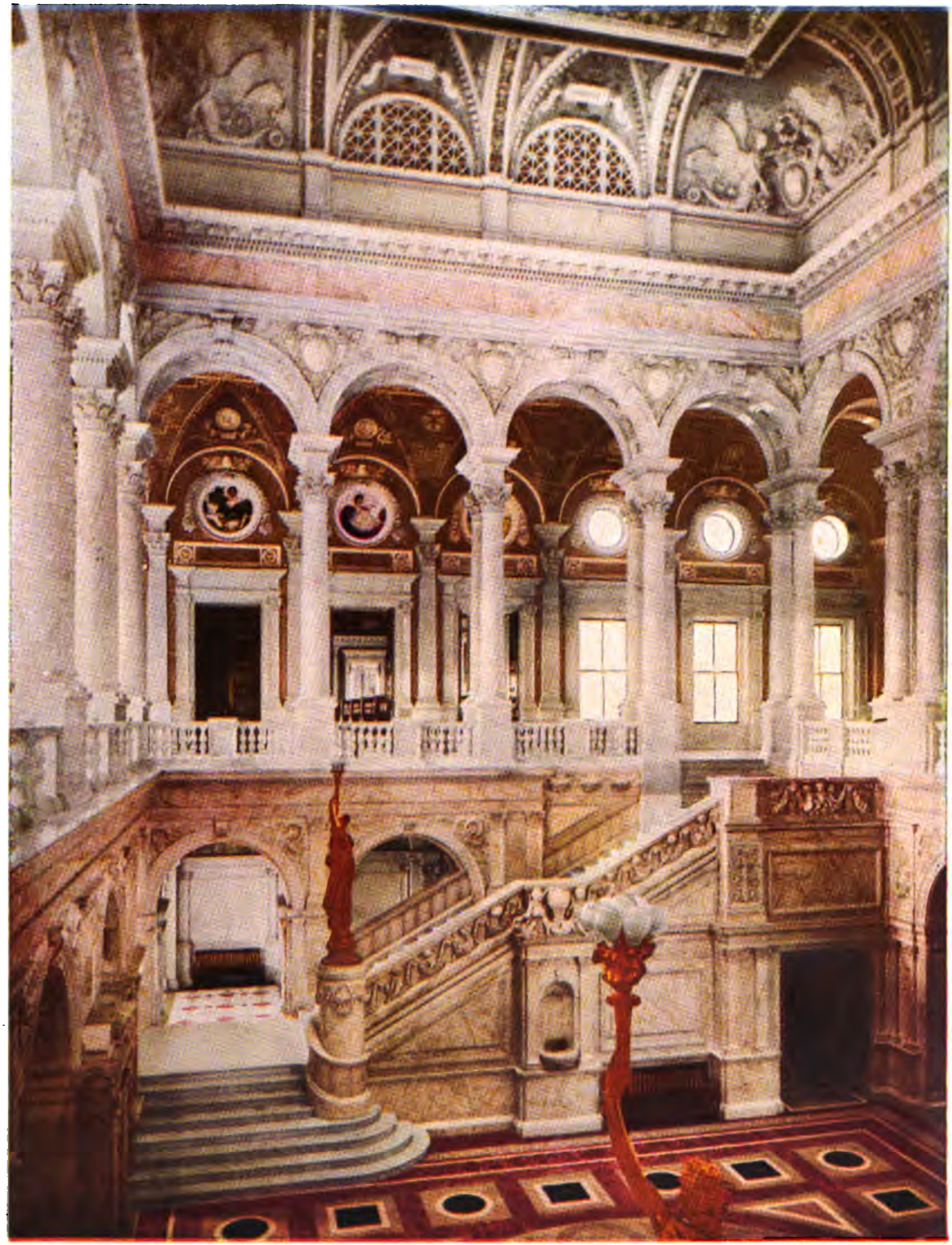

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PUBLISHER'S PREFACE

WE are living in the beginning of the world's most wonderful age. The old is passing away with revolutionary changes in nearly all fields of human activity. National life is moving on new and higher planes of thought and action. We are talking through space over land and sea, under the earth and the deep. We are dashing over the highways at express speed, while electricity is supplanting the slower acting force of steam. We are changing desert lands to garden areas; and the human mind has outdone the work of nature in developing new forms of plant life. We stand in awe as the finite mind attempts to grasp the marvelous advance in science, industry, and art.

This is also an age of education. The demand is for the man or woman who knows and whether a college education is within reach or not the aspiring youth of the present day may rise to prominence by utilizing opportunities on every hand for self development. But only he can hope to realize the benefits of this new age who brings to the solution of present day problem the energies of an alert, well informed mind.

To assist those who aspire to the larger and richer life that comes only to the well informed is the primary purpose of The New Knowledge Library. To serve this end, information from every field of human activity that can give breadth of vision, clearness of thought, and keenness of perception has here been condensed, classified and presented in a logical and pleasing form. This material has been arranged so the reader can find what he wishes quickly, and get to the heart of his subject.

Thus this volume is at once a ready reference library as well as a volume for pleasant home reading, and he who uses it becomes well informed on vital subjects, thus gathering a fund of reserve force that in times of need classes him as one who knows. It is not possible to exhaust in a single volume the important subjects touched upon in this, but sufficient has been given to satisfy the casual reader and to suggest further research to the earnest student. The advantages to be gained depend largely on the reader himself; on his strength of soul, earnestness of purpose and fidelity to the course marked out.

It is our part to gather this store of information, arrange it in suitable form, and devise suitable aids to help the student on his way. To assist him in fixing in mind the information gleaned from these pages a series of questions follow each of the books. These questions test the thoroughness of the reader and his understanding, and indicate in what respects a more exhaustive study is desirable. The table of contents gives the subject matter of each book so that points of special interest may be studied. The Index is invaluable to one who would specialize in some particular field.

In Book I Some of the Marvelous Inventions and Discoveries of recent years are considered. Advance in this direction has been so rapid of late that we are almost startled at the results laid before us. When the century opened wireless telegraphy had just been achieved. Who would have dreamed of the wonderful expansion of the application of electricity to human needs that we witness today! It is enriching every phase of modern life. Accordingly this volume opens with the marvels of electrical advance which will be a revelation to even the well informed.

Equally surprising have been developments in aircraft. It is safe to say that advance has been made in this direction, under the stern necessities of war, that would have required many decades in ordinary times. This record constitutes an amazing story of human progress. The application of science to purposes of war have also been outlined in that book. Aircraft have been balanced by submarines. Dreadnaughts of the surface are menaced by cruisers of the deep. On land aerial scouts replaced the cavalry of former wars, and telegraph, telephone, and wireless methods take the place of message bearing orderlies of earlier years.

Book II gives a graphic account of the wonders of industrial development. Among the other important industries which we find described in this department, are the modern newspaper and printing industry. It is difficult to overestimate the value of the press in the matter of the great newspaper as an educational medium. The activities of the entire world are passed into daily review in the columns of the great metropolitan papers, and the important happenings are depicted to the reader through their great educational force.

The industrial field is so extensive and embraces such a variety of important subjects that it is difficult to select and properly classify the information that must be collated and arranged properly to serve the purpose of a volume of this nature.

Under the general headings of Transportation, including railroads, electric lines and water borne transportation, mining, agriculture, and manufacturing, statements and figures are given which astonish us as to the magnitude of operations, and enthrall us with inspiring accounts of progress.

Book III is designed to give us a more intimate acquaintance with the great nations, with emphasis upon our own. Every American should strive to know America. Some nations have a great area, others a great population, and others excel in some minor respects. But no nation, as a whole, surpasses that of our own—America. In all factors of material well being every American citizen can take a just pride as we study the great nations by comparison and contrast. Some of the great natural wonders of the country have also been depicted. In no section of the world has nature left greater wonders to attract attention and instruct the mind, and to arouse the feelings of sublimity in all than in our own native land of America. In a similar way, though not with the same amount of detail, interesting information has been gathered of other countries and other peoples.

To the south of the United States are located the various republics of Latin America. This widely extended sweep of country with its vast area of fertile land, the large river valleys, exhaustless mineral resources, is a country with a great future. No section is more responsive to modern influences. It would be impossible to condense a greater amount of valuable information concerning these various republics into the amount of space here given to this subject. Comparison of the different countries is made and their strong points are impressed more firmly by this process. In the same way the reader is made acquainted with the distinctive features of the principal nations of Europe and Asia.

Book IV, "The Recent Advance in Popular Science," contains information that will be a revelation to many. By the simple process of studying nature's methods of work we have achieved wonderful advance in knowledge of plant development. The world has been startled by the achievements of pioneers in this work. It is a section of enthralling interest. We are bewildered as we contemplate future possibilities. In the history of science there are no more amazing statements than those used to set forth present day conclusions as to atoms and the origin of matter. The secrets of the infinitely small not less than those of the infinitely great are opening before us.

Books V and VI are veritable mines of information of the most practical nature, making for mental strength.

No matter what the profession, trade, or business in which one may embark, questions of importance come up daily which require the power of decision. In deciding these questions it is not necessarily technical knowledge that is needed. Indeed one may not be aware of the reasoning on which decisions rest. But in this volume one can acquire the breadth of vision, a clearness of perception and the facts which are often needed in solving important questions arising in daily life.

Book VII, "Our Government," is most timely. It is now more than ever necessary that every American youth should be thoroughly acquainted with the government under which he lives. The recent world conflict has drawn sharp contrasts between the governments of various countries, and our own America stood out in bold relief. In the preparation of this department, graphics have been produced for this work, which make clear to the mind through the eye, how each department is conducted and the various responsibilities assumed by the head of each department and each person connected with the same. The knowledge contained in this department is not simply an embellishment to a liberal education, but is a present day necessity for one who aspires to be a leader among men.

The world is not so large as it was in the days of our forefathers. Whether we would or not we must take a larger part in the activities of other lands. The statesmen of the future will have to consider many questions that were safely ignored in earlier years. In every town, city or hamlet the molders of public opinion must be familiar with our government as it is so as rightly to judge the governments of other lands and to state intelligently the differences between them.

Book VIII not only explains the "How" of many manufacturing processes but it is purposed to stimulate creative imagination and incite others to apply their talents in a way that will benefit their fellow men.

If this volume can be said to be for one class more than another, it is for the young; for those who entertain an ambition to make much of life, and who desire to be well informed and to be numbered with the progressive thinkers of the day. It is right and natural for all to be influenced by such aspirations, and to grasp every aid to realize these ideals. To all such the accomplishment of ambitious and successful leaders in the various fields of invention and research will be subjects of impelling interest. This volume, however, is not designed for the young alone. It covers a field of vital interest to all and will appeal to all ages and conditions of men and women desiring to be well informed.

Examples are on every hand of men who, showing themselves superior to handicaps, are able to rise above adverse conditions, but one of the essential factors of such advancement is the pitch of mental strength, poise of judgment and breadth of vision that acts with the power of prompt decision which can come only from knowledge.

Hundreds of fine illustrations, half-tone and color plates have been used to embellish this volume, that it might not only be more attractive but illustrate the text matter in such way as to make the facts easier to comprehend. These illustrations have been procured at an enormous expense and great labor. Intricate machinery and interior of factories have been pictured; many foreign views procured; the good offices of the Government have been drawn upon, and a fine series of views obtained at a great expense.

This volume is now sent forth on its mission of education, inspiration and self-development. It is born of the exigencies of the time. It goes with a message of encouragement and help, supplying the means of advancement and stimulus to action. In the cities, towns, country villages and rural homes there are ambitious young men and women seeking opportunity for advancement. This volume is the answer to the call. May it touch the life of millions and accomplish the purpose for which it is designed.

THE PUBLISHERS.

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July 10th, 1919.

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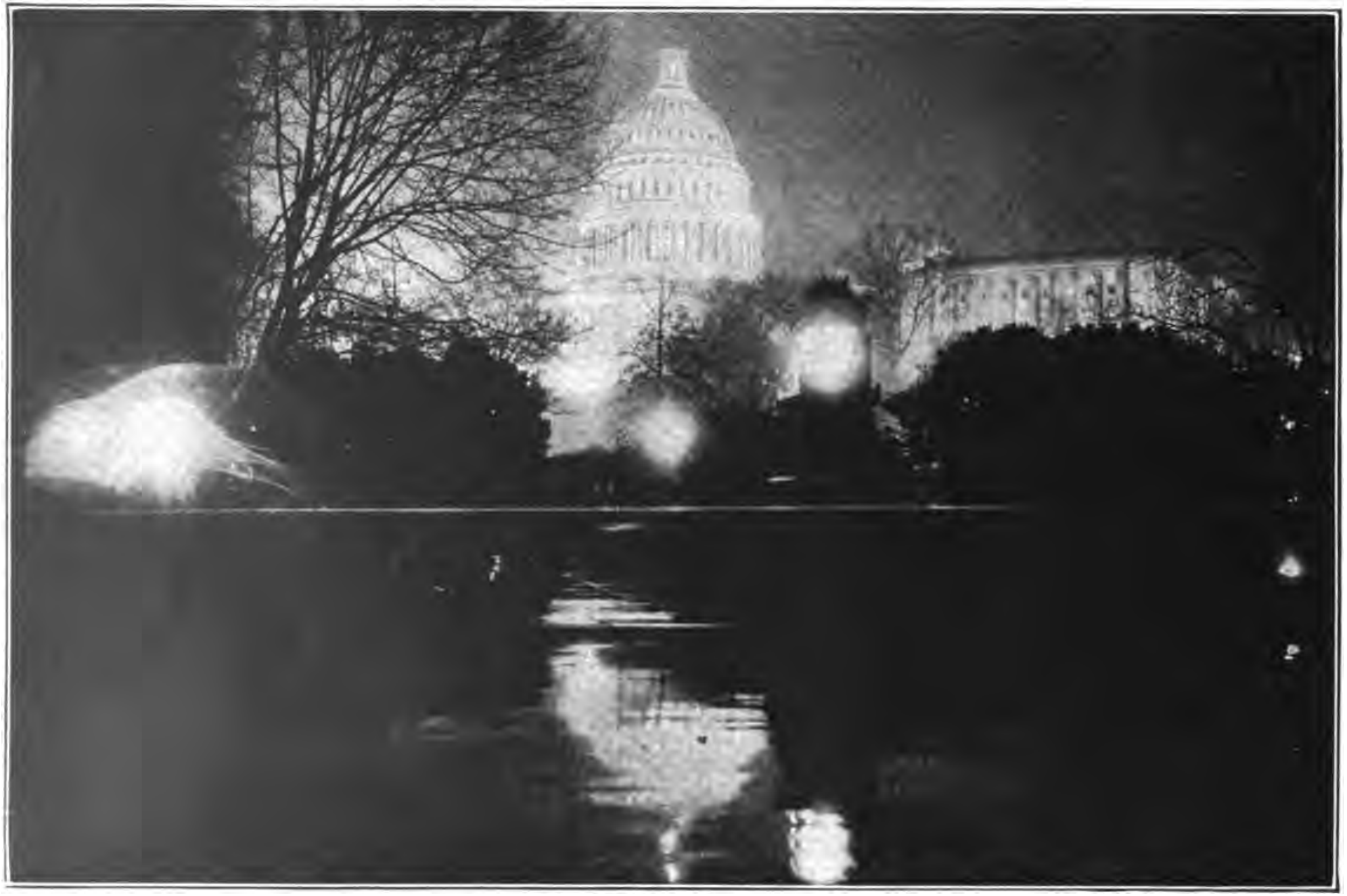
BOOK I

MARVELOUS INVENTIONS AND DISCOVERIES

Wonders of Electrical Discoveries Portrayed. A Glowing Description of Airships and Flying Machines Warfare as Revolutionized by Modern Science. Wonderful and Striking Achievements of this Inventive Age. Triumphs of American Ingenuity.



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THE CAPITOL BUILDING AT WASHINGTON ILLUMINATED FOR AN INAUGURAL.

This scene shows the weird beauty of the hundreds of electric and search lights. Thus illuminated the great dome can be seen from a distance of many miles.

ELECTRICITY AND ITS WONDERFUL APPLICATION TO MODERN INDUSTRY, SCIENCE AND ART

The study of electricity takes us far into Nature's secrets and we are lifted to higher planes of thought for we are studying that into which all other forces vanish, from which all other forces emerge. Invention is quickened and we discover numberless ways whereby to make life richer. Advance has been wonderfully rapid in recent years, and the many useful inventions resulting are completely changing industrial life. By the aid of electricity we rival Nature in building up chemical compounds, it is revolutionizing the manufacture of iron and steel, it is outdoing the work of steam; it is carrying our messages through space; we are whispering across the Atlantic; we are talking through the ground and under the surface of the seas.

In by-paths of activity it is performing countless services. From the smoke and gases of furnaces, founderies and smelters, it is extracting untold stores of wealth. Its multiplied services are enriching rural life, bringing to country homes comforts before denied. It is drawing from Nature's storehouses supplies of energy that are revolutionizing manufacturing in distant cities. The results form an inspiring story of human progress. When we consider what has been accomplished in the brief span of years since the century began, surpassing all that went before, we glimpse future possibilities that quicken thought, that give us higher ideals of life. Let us then begin this volume of education with a review of present-day knowledge of electricity and its wonders.

EVERYWHERE BUT UNSEEN.

Electricity is in the storm and in the sunshine; it is present in the air, in water, and in the earth; it comes to us across space,

FRANKLIN AND HIS KITE.

keeping company with light and heat, but we notice it no more than we do the pressure of the air. We know how to generate it, how to set it to work, but just what it is, is unknown—that is one of Nature's most closely guarded secrets. Our practical knowledge of electricity is a matter of comparatively brief time. Franklin with his famous kite showed that electricity and the force back of lightning was the same force. In every department of discovery Nature seems to allow only tantalizing bits of knowledge to escape her keeping until the time is fully ripe; then discoveries come with a rush. As the nineteenth century was passing into its last quarter we suddenly come upon such great names in the history of electricity as Edison, Gray, Bell, Tesla and Marconi; with them, the modern day of electricity began.

ELECTRICITY FOR INDUSTRIAL NEEDS.

If electricity is to serve our purposes in modern industrial life we must be able to produce it in quantity. The raw material used is some other form of energy. The great lesson of modern science is that while we cannot create energy, we can change its form of expression. Thus the great energy of falling water as at Niagara, or that of currents flowing over rapids, as at Sault Ste. Marie, where the stream can be dammed and thus a head of falling water secured, can by suitable mechanisms, be transformed into electricity. Or a vast amount of energy in the form of heat can be secured from burning coal, which can be similarly transformed. In the form of electricity it becomes an ideal power, because it can be sent almost any distance by means of copper wires and set to work at its destination. We may in the future learn how to utilize other sources of power, such as heat derived directly from the sun's rays; or we may invent some practical way to harness the tides; or we may utilize heat from the interior of the earth. This seems fanciful, but a beginning in such use has been made near Vesuvius, Italy. Finally, we may be able to tap the exhaustless stores of electricity that flood out from the sun. Further advance in the application of electricity to the purpose of industry will depend on improvements in methods of production, and in effecting further economies in the process. To the solution of these problems, the best engineering talent in America is devoted.

HOW ELECTRICITY IS SET TO WORK.

Without making use of technical language, we must explain the means by which electricity is made to do work. In an air compressor, the air is under pressure perhaps in a long tube, some distance away; perhaps half a mile distant it is doing work, say driving a drill. We do not and cannot generate air. All we can do is to place it in such a condition that work can be accomplished. There is a strong resemblance between that compressed air and a current of electricity. We do not and we cannot create electricity. What we can do is to put it under pressure, to drive it as it were, and so enable it to do work. Another point we should understand is that when we thus drive electricity through or along a conductor—say a copper wire—there is always a disturbance in the ether surrounding the conductor; so that if there be another conductor near by, these waves of etheric disturbance set up corresponding electric currents in the stationary conductor. There need be no mystery about this, since action and reaction are equal. Grasp this concept for here is the secret of what is meant when we talk about generating electricity, and setting it to work and finally, it is the only present explanation of all wireless methods.

Courtesy Robins & Myers Co.

THE DYNAMO.

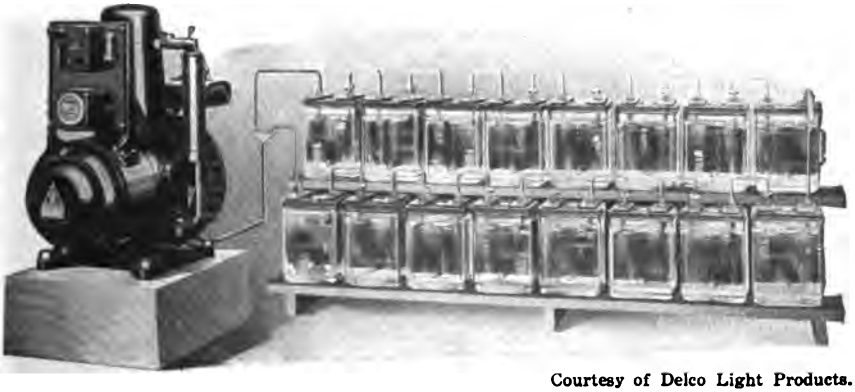
Dynamo is the general name of the machine converting the power of falling water or of steam into electricity. The insulated wires are wound around the central part, which is swiftly revolved around the central core.

THE DYNAMO.

In the dynamo this principle is employed. By means of power derived from a steam engine, or water-driven turbine, immense conductors, made very strong by means of insulated wire closely wound around them, are revolved around other conductors in which strong currents of electricity are excited as just pointed out which, speeding away, are operating an electric motor at some distant point. The motor is in all essential respects a dynamo in which the action is reversed. That is to say, in the dynamo revolving conductors set up a current in the stationary conductor; very well,—since it is a poor rule that will not work both ways,—a strong current of electricity in the stationary conductor will set the revolving conductor in motion, and by suitable machinery that motion can be made to do all sorts of work,—revolve car wheels, drive drills, or any work that steam-driven machinery could accomplish. The foregoing statements are expressed in general terms and in simple language, but they convey essential facts.

HOW ELECTRICITY IS STORED.

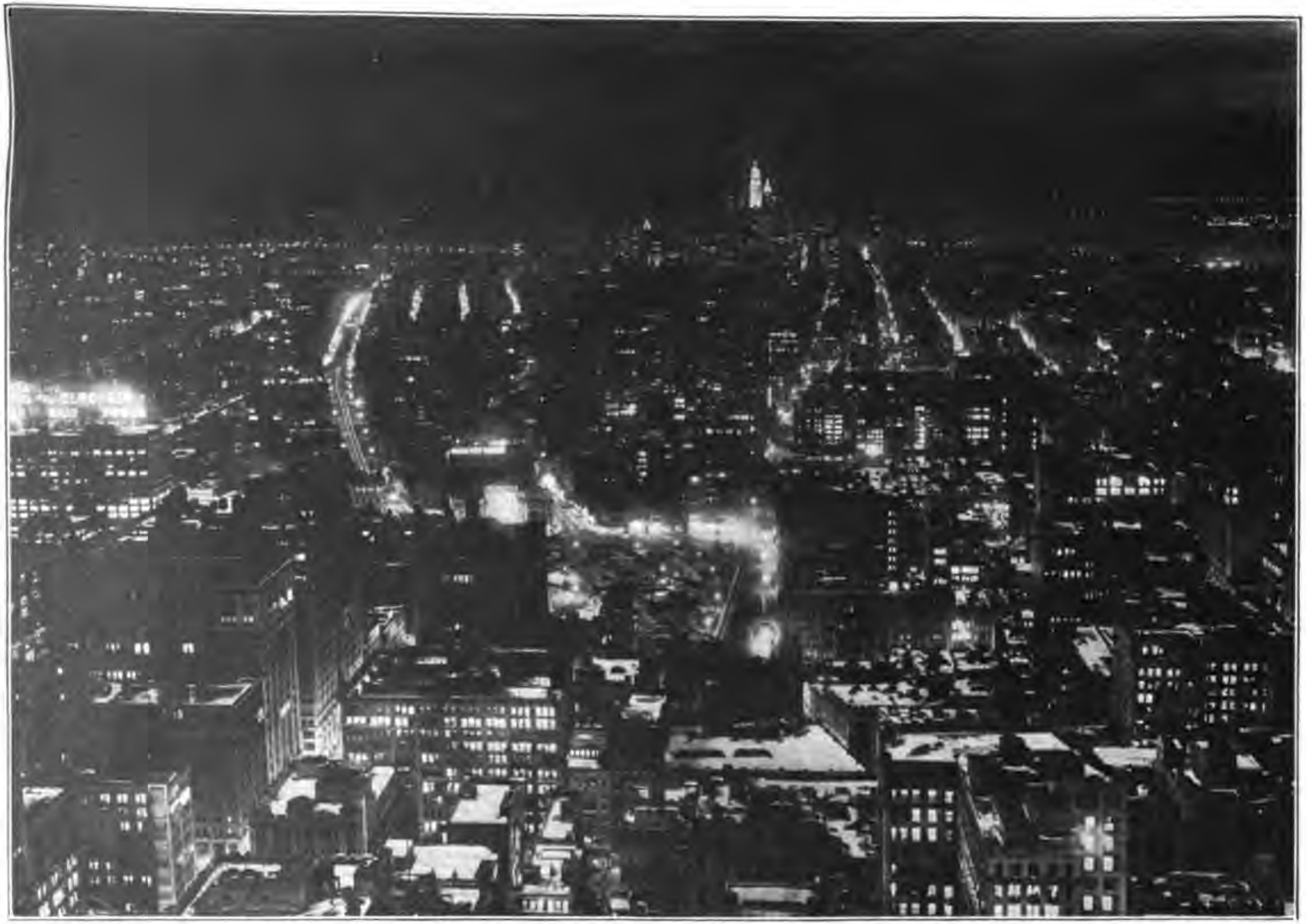
In employing compressed air we know that we store it up under great pressure in strong cylinders or other containers, and when we wish to use it, opening a valve gives us the current. On this principle, the air brake on car is operated, and also all compressed air machinery. In a faintly analogous manner we can store up electricity under pres-



Courtesy of Delco Light Products.

A STORAGE BATTERY.

In this battery notice 16 cells, properly connected. It is charged from the dynamo which is itself run by kerosene, gas, or gasoline. Electricity thus stored is used for many purposes in the home.



NEW YORK BY NIGHT. Courtesy New York Edison Co.

New York South of Madison Square.

Far away in the remote background is the light-flooded Woolworth Tower, with the dome of the Singer Building as a satellite. In the left background twinkled the lights of Brooklyn Bridge. The broad, curving thoroughfare to the left is Fourth avenue, where it becomes the Bowery. In the distant background in the upper right-hand corner one may see the feeble rays of the lights on the Communipaw water front. In the middle distance is Union Square, with Broadway leaving it parallel to Fourth Avenue.

sure, as it were, in storage batteries that we can carry with us to be used when occasion requires, as in electric automobiles. The essential facts are these: two strips of lead are exposed to chemical action in such a way that an extra supply of oxygen is stored up on one plate,—the peroxide of lead,—and hydrogenated, or spongy lead, forms on the other. When these strips are again connected by a wire a current of electricity at once begins to restore the balance in the two strips, and that current can be made to do work, and when a number of these cells are arranged in a series all properly connected we have a modern storage battery.

ELECTRICITY LIGHTS OUR HOMES AND STREETS.

Electric lighting is one of the most practical and, all things considered, one of the most important developments of electrical energy as applied to the comforts of man that has yet been accomplished. We are so used to it that we do not realize its importance. A turn of a switch in some central power house, and the city streets are light: an equally simple movement of the hand in office, in factory, in our home, floods our room with light. As an advertising medium the streets of all our large towns are aglow with lights in festoons, in streamers, in shimmering letters, or tastily arranged signs attracting our attention to the business transacted where they are displayed. These multiplied uses of the electric light are familiar to all. At the Centennial Exposition in 1876, there were but two exhibits of electric lights; that fact affords a measure of the stupendous advance since achieved.

THE ELECTRIC ARC.

When two pieces of carbon are held closely together, end to end, and a strong current of electricity is sent through them no light appears; but if the carbons are separated a short distance, say an eighth of an inch, the current leaps across this space. In so doing it meets resistance, and consequently heat is engendered that soon causes the carbon points to glow, and the glow increases in intensity until the points become highly incandescent. In addition the space between the heated points is filled with white hot particles of carbon flying from the positive carbon to the negative carbon, and thus the electric arc is formed. The light is not made by the current of electricity itself, but is produced by the great heat generated because of the resistance made by setting up the air-space obstacle in the path of the current. The heat between the points is great enough to melt platinum, clay, granite, and other substances, that can be melted only by the most intense heat as in electric furnaces made by inclosing large carbon rods in fire brick and "striking" an electric arc by means of a strong current.

As the positive carbon wastes faster than the negative, it is placed above the negative carbon in the arc lamp, and clock work mechanism feeds it down, either continously or at short intervals, so that the space between the points remains constant, thus the lamp burns until the current is switched off or the carbons are consumed. The electrodes are not always carbon, they may be carbon that has been metalized, so to speak. The arc may be open to the weather, or inclosed; there are certain advantages peculiar to each form. The light is called an arc because even when passing between vertical electrodes it is swayed to one side by the earth's magnetism. Any two electrodes will yield the same result; all things considered, carbon is the best. A luminous lamp, extensively used, has an arc between a copper electrode and a lower magnetite one. There are also certain substances that can be used as electrodes that furnish an arc comparatively low in temperature but of great illuminating power. To this class belong most vacuum arcs.

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A POWERFUL SEARCHLIGHT.

A searchlight used for war purposes such as to detect the movement of troops or to discover the presence of air craft. This is the light proper. It has a sixty centimeter mirror, the back of which is shown. The cable on the ground leads to a dynamo wagon, which furnishes a current of 60 ampere. The largest searchlight in the world is located in New York. One can read by its light at a distance of over a mile.

USE IN PEACE AND WAR.

The arc lamp is extensively used in street lighting; but it is too brilliant for ordinary rooms, and as it rays are sent forth from a single point they form shadows of sharp and unpleasant definition. Strong arc lights, mounted upon a tower and furnished with a reflecting mirror become search lights of value in peace or war. For peace they disclose to mariners the path of safety; in war they detect troops massed for attack; or, flashed to the skies, show approach of aerial fleets.

THE INCANDESCENT LAMP.

This is such a very common lamp that we accept it as a matter of course but have no conception of the immense amount of research work required to make it a success. Everyone knows that friction will produce heat and heat, increased, results in light and fire, provided in the last case there is oxygen present to unite with the heated substance. Further we can all see that if a current of electricity is passing along a wire but something resists its flow at a certain point yet allows the passage of the current intense friction, heat, and light are going to follow. The probabilities are that the line will be instantly burned out, but let us suppose that the substance of the conductor at that point is very refractory,—that is, not readily yielding to fusion,—very strong, and is drawn out in a filament, and finally that it is inclosed in a vacuum bulb. Such a filament is going to light up at once and glow with an intense power. These are the essential facts in regard to the incandescent lamp.

THE SHINING FILAMENT.

To illustrate the great amount of research work demanded to produce a practical lamp consider the filament. For many years carbon filaments only were used. This line of research required years of time and a great outlay of money. Every characteristic North American fibre was tested in vain, and so explorers were dispatched to South American and Africa to gather other fibres in the greatest variety. At the end of many thousands of experiments, finely divided and shaped strips of bamboo gave results:—That was yesterday.

As in all inventions, improvements rapidly followed. Today the carbon filaments are prepared from cellulose in the form of cotton dissolved to a viscous condition and forced through dies and so emerges as smooth threads which, in turn, are subjected to many processes. The metal tungsten is being used more and more. It gives excellent results. It is a good conductor, extremely refractory, — melting point 3,200 degrees—an immense amount of work is required to produce such filaments. The tungsten must be melted, forced through dies, the resulting filament subjected to many other refining processes. Other metals and combination of metals are also used. When you view an incandescent electric light, think of the years of research work required to produce the light which you enjoy. But inventors are still busy and every year sees some new improvement.

ELECTRICITY USED TO GLEAN MARVELOUS STORES OF WEALTH FROM SMOKE AND DUST.

One of the most unique applications of electricity, but also one of great economic interest, has lately been perfected. It is the use of electricity to precipitate the free particles of foreign matter in a gas. Unless one has looked into the matter, one has only the faintest idea of the wastage represented in the fumes from belching smoke stacks. A large smelter pours out 5,000 cubic feet of gas per minute. In that gas is a large amount of sulphuric acid and mineral matter that are harmful to life and death to vegetation. The simple process of making that gas pass through an electrified space precipitates the impurities, thus rendering it harmless, and what were impurities turn out to be valuable assets. The device that effects this is known as the Cottrell Electrical Precipitator. One smelter at Great Falls, Montana, the first year after installing the electrical process saved $180,000 worth of copper, gold, and silver that was going to waste. A cement plant at Riverside, California, gathered up 100 tons of dust daily that had been blown broadcast over the orange groves and vineyards of that section, of course, ruining them, besides constituting a menace to the health of the entire neighborhood. But that is only half the story, that dust is rich in potash, and therefore so valuable that the mill was actually run just to secure it. Calculations show that enough potash to supply the needs of our entire country goes to waste yearly; not to mention the waste of other valuable materials. This shows the economic possibilities in this application of electricity.

DEATH TO VEGETATION.

The Cottrell Electrical Precipitation Device prevents the escape of clouds of dust from cement work or the immense clouds of smoke from smelters, and extracts valuable by-products from them.

CENTRAL POWER PLANTS.

The real electrical age is just dawning. In spite of the vast amount of electrical energy now used, we have passed through only the preliminary stage. Far-seeing electrical engineers speak of a time rapidly approaching when not only every town but every farm, mine, or isolated home, will be able to obtain electric power and use it with almost the same disregard of cost that dwellers in large towns now show when they turn on water for their needs. Why mine coal and transport it hundreds of miles for the use of individual factories and homes when immense power developing plants, employing the wonderfully efficient steam turbines of today, can generate power and send it by wires to towns, cities, and manufacturing centers hundreds of miles distant? Recent improvements have so perfected the transmission process that it is no longer a question of doubt that such operations are practical. Immense power plants in Alabama and Pennsylvania are demonstrating this fact. At present, more than 12,000,000 carloads of coal are travelling broadcast over our country to supply individual needs. At least half of that transportation could be saved by converting the energy latent in the coal into electrical energy at the pit's mouth and allowing the current to carry itself over the wires to the places where needed.

In Alabama the industries of the State largely secure their power from great power plants, the largest of which gets its fuel at its own back door, at the mine shaft a few hundred feet away. Similar centralized plants are now installed in the Wilkes-Barre coal section of Pennsylvania which send currents to the monster steel works at Bethlehem. This is only a foretaste of what can be done—and doubtless will be done—in the future.

ELECTRIC POWER CHEAPER THAN STEAM.

The mere saving of transportation charge is only a part of the total savings to be effected. The Department of the Interior asserts that in generating steam power in the scattered manufacturing plants of our country only about five or six per cent of the total energy is made available; but by employing large turbo-generating units, about twenty per cent of the total can be made available in the electric current. That means that one pound of coal will become four times as useful when its energy is transformed into electricity as when used to generate steam. The story is not fully told even yet. In the immense central power houses we are considering many labor-saving devices, such as mechanical stokers can be employed; further by improved furnaces they can use slack not available for all purposes. Then again, such saving devices as the Cottrell Precipitating Plant can be used and great stores of by-products saved. Production always follows the lines of least resistance, and by reason of these facts the time is approaching when immense central power plants, located in coal fields, or in places where great waterpower is available, will usher in the real age of electricity.

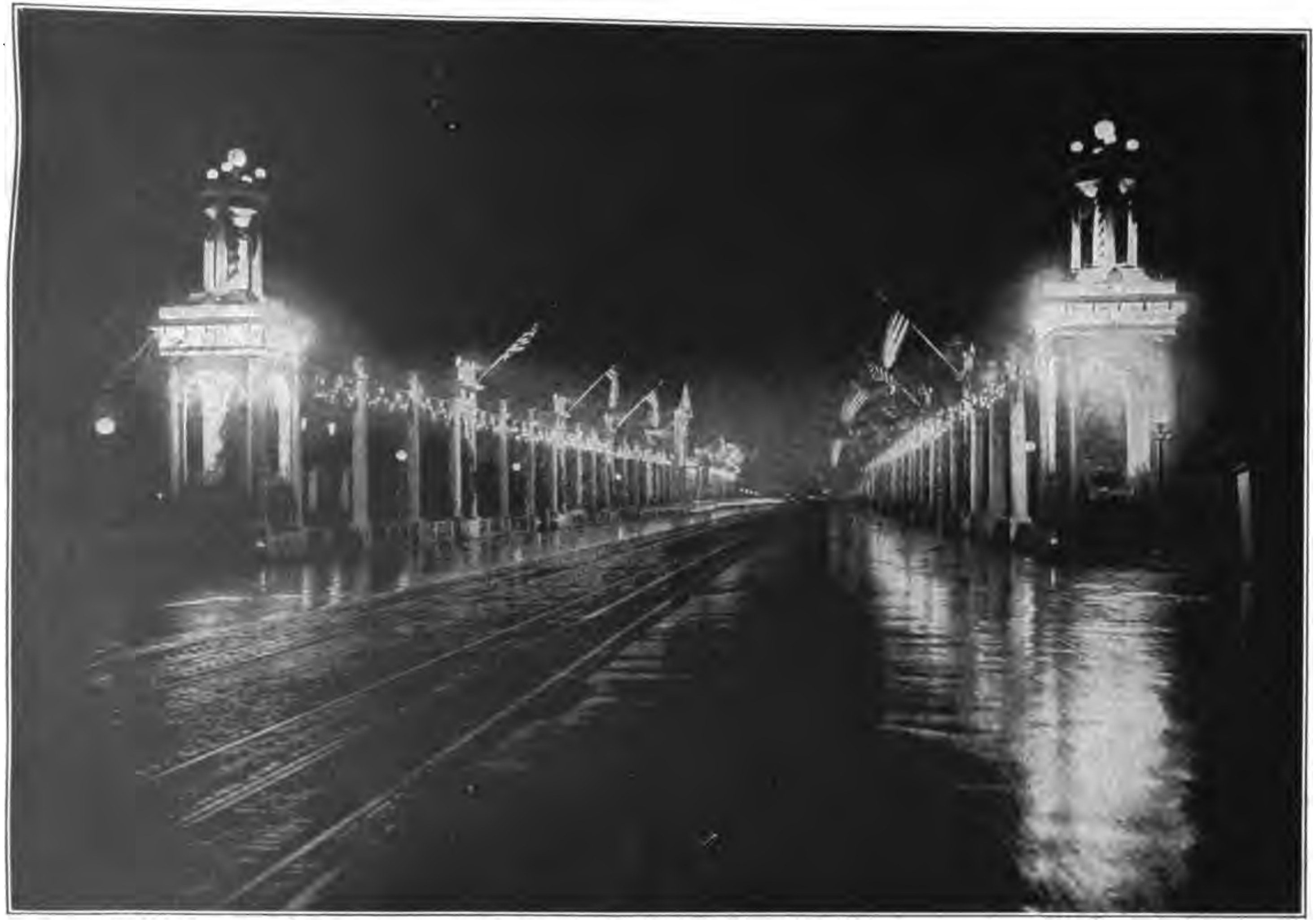
Courtesy C. M. & St. P. Railway.

HYDRO-ELECTRIC POWER PLANT AT LONG LAKE, WASHINGTON

This is the power plant that will develop electricity to operate the division of the C. M. & St. P. Railway covering the Cascade Range in Washington, 211 miles in length. Here was vast wealth formerly allowed to waste, now serving the needs of transportation.

OUR VAST WATERPOWER POSSIBILITIES.

But Mother Nature is ready to enter into a benevolent partnership with us in the production of electricity for the new age. She has endowed our country with a most generous amount of waterpower. A most expressive name has been bestowed on this form



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INAUGURAL COURT OF HONOR ILLUMINED FOR VISITORS.

We are so accust electric nd the beautiful effects that can b produced by them that we fail to realize the long years of patient research work that enabled th be . Notice the myriads of lights and their beautiful effects in this view, only to be seen when a president is inau ted.

of power,—it is called White Coal; and, really, since the latent energy in coal and the active energy in moving water both trace back to a common source—the sun—the name is appropriate. In both cases, these sources of energy have always existed, only within comparatively recent times have we learned how to utilize that energy; transforming it into electricity is its latest application.

RECKLESS WASTE OF WEALTH.

According to the Geological Survey in our country there is over 60,000,000 horsepower of energy in waterpower that could be used. We are using only about six million horsepower. We do not realize what this wastage costs the people of the United States. It represents as much energy going to waste as the latent energy in 450,000,000 tons of coal. Every ton of coal saved means more and better labor for the farmer, the railroads and the manufacturer, and it means cheaper transportation, since it lessens the cars and equipment devoted to transporting coal. In any one of the three northern New England States enough waterpower could be set to work to supply the needs of every factory in New England; as it is, power from Ver-[illegible] is working in Central Massachusetts. [illegible] is hardly a state in the Union in which proper conservation of waterpower would not supply its needs. Immense power has [illegible] utilized at Niagara, but doubtless much [illegible] will be used in the future. Power so produced is transforming the manufacturing industry of nearby towns; it can be sent to Cleveland; there is even talk of sending [illegible] to reinforce the marvelous industries of Detroit. At Sault Ste. Marie other enormous power plants are enriching Canada. It was the Falls of Saint Anthony that made Minneapolis possible; transformed to electricity, it promises a more wonderful development in the future. Nature offers us untold wealth; we are tardily accepting her offers.

MARVELOUS ADVANCE IN RECENT YEARS.

We do not realize how rapid has been the advance in the use of hydro-electric power recently. A few years ago a current with a voltage of 60,000 was deemed the limit and the distance of transmission was comparatively short. In the Sierras of Southern California there is a mountain stream that in the course of six miles, descends over 4,000 feet. Here was enormous power—equal to all that the great Keokuk dam could produce—going to waste. It was set to work generating electricity and now a current with a voltage of 150,000 is sent across mountains and valleys, orchards and deserts, a distance of 240 miles, and supplies the electric needs of Los Angeles. Plans are worked out to secure from the Zambesi Falls in South Africa a current of 200,000 volts to be transmitted 700 miles. That voltage represents only a small fraction of the total energy that could be utilized.

WHAT IS MEANT BY VOLTAGE?

It is necessary to define voltage for the term constantly recurs in talking about electrical work, transmission of power, etc. Suppose you had a tank of water on the top of a high building and another tank of same size on, say, the second floor of the building with pipes leading from each tank to the ground. The streams of water issuing from these two pipes would emerge with different amounts of force. That coming from the top of the building might possess several times the energy of the one from the second floor. The pressure of the stream of water is analogous to voltage in an electric current. We measure the intensity, so to speak, of the current in terms of volts.

THE FLASH OF A 400 THOUSAND VOLT HIGH PRESSURE LEAD

HOW ELECTRICAL CURRENTS ARE MADE READY FOR SERVICE.

We can also see that where as currents of tremendous voltage power can be sent away from central power plants to a manufacturing center, they would have to be toned down some way before they could be employed in various industries. The mechanism that effects such a result is a transformer. There are two classes of transformers; those that step (transform) currents down, and those that step them up. It is useless to undertake their description. We might remark, however, that in a watch you have the motion of the balance transformed by the wheels to fit the slowly moving hour hand, the more rapidly moving minute hand or the needs of the comparatively swiftly moving second hand. Electric currents are of two classes: alternating and direct in simple language. A direct current is a steady flow comparable to that of water in a pipe, from a point ot high electrical tension to one of low potential. An alternating current, on the other hand, changes its direction at inconceivable minute intervals of time, which action is faintly analogous to the reciprocating motion of a shuttle in a loom. Immensely greater power can be transmitted in the form of an alternating current than in a direct one, so power is transmitted in the form of an alternating current but for working purposes it must be transformed to a direct one. For various purposes then electric works have testing devices. Our illustration shows an instantaneous photograph of a high-tension lead "flash over" made during a test of four hundred thousand volts. By this means the insulation of transformers is tested so that the turn insulation, the insulation between coils, and that to the ground may each be made proportional to the demands made upon it in actual service. These high-tension tests are truly scientific and obviate the possibility of using a defective piece of material.

HOW ELECTRICITY HELPS INDUSTRIAL DEVELOPMENT

We have noted the great increase in the practical application of electricity in our land. It is the same in other lands. Norway is making wonderful strides in this matter. Canada is so richly endowed in this respect and is making such progress in utilizing her stores that Lord Kelvin long since prophesied that Canada would be the leading manufacturing country in America. There are immense possibilities in other lands. In South Africa, utilization of only a fraction of the power 'of the Zambesi Falls would enrich all that section. A wealth greater than the gold of the Rand or the diamonds of Pretoria, at present goes to waste; it will not be so in the future. It is the same in large parts of Asia, and is pre-eminently the case in South America. We are blind if we do not see in this phase of electrical development—the production of power for industrial purposes—the factor that is going to make the epoch on which we are now entering the most wonderful in the history of man. Freed from the fear of conquest and selfish exploitation at the hands of a designing power, we enter on a career of progress marked by the utilization of a mysterious force into which all other forces transform, from which all other forces emerge—Electricity.

HOW WATER IS MADE TO SERVE IN PRODUCING ELECTRICITY.

Where Nature has not supplied convenient cascades she invites us to build dams and make our own head of falling water. In many places dams are needed for other purposes, but there is no objection to making the impounded water do its bit before resuming its normal flow. A notable instance is the great dam across the Mississippi at Keokuk the primary purpose of which was to furnish a safe passage for steamers over the rapids at that point; but naturally a powerful hydro-electric plant was installed, which furnishes two 110,000 volts currents to St. Louis and one of 11,000 volts to Burlington, Iowa. The plant also furnishes electricity to operate the ship canal locks and to supply other needs of the service.

HOW ELECRITICITY WILL CREATE AGRICULTURAL WEALTH.

Keokuk is only one instance of many that occur to all. Every year we read of new plants being erected. The government is building a $50,000,000 nitrogen fixating plant at Muscle Shoals, Alabama. To fixate nitrogen requires an enormous electric power which is generated by damming the Tennessee River. While the immediate purpose of the plant was to produce nitrogen to be used to manufacture ammunition, it will be utilized for the production of fertilizers and thus increase agricultural wealth. Another of these immense hydro-electric power plants was erected near Charleston, West Virginia.

USE OF ELECTRICITY IN TRANSPORTATION.

Of course, all are familiar with the use of electricity as a transporting agent employed in our trolley lines and elevated and subway lines in cities. What is not so generally known is the increasing use of electricity on our railways. The electric locomotive bids fair to supersede in time the steam locomotives. The electrification of

Courtesy of C. M. & St. P. Railway.

THROUGH AWE INSPIRING MOUNTAIN GORGES.

The "Olympian Flyer" traversing the beautiful scenic section of Montana. Notice the Mammoth Electric Locomotives controlling the train. As the train is on the down grade, instead of consuming electricity it is producing it and helping a train up grade a hundred miles or so away. Just another electrical marvel.

steam railways is proceeding at a constantly accelerating rate; it will not become general until we can produce electricity in a much greater volume and at less expense than at present, but for some purposes it is coming into general use. Important railroad terminals—as in New York, Philadelphia and Chicago—are being electrified. The Norfolk and Western Railway is a coal road and the traffic is very heavy. At one place there is a section with a very steep grade over the Allegheny Mountains. In order to move a 3,000-ton train up grade the service of three Mallett compound steam locomotives was required, and the running speed was only seven miles an hour. Two electric locomotives now haul a train of 3,250 tons up the same grade at a speed of fourteen miles per hour. In various other ways increased efficiency is noticeable. Twelve electric locomotives are doing as much work as could be obtained from thirty-four monster Mallett freight engines.

A MODERN ELECTRIC LOCOMOTIVE

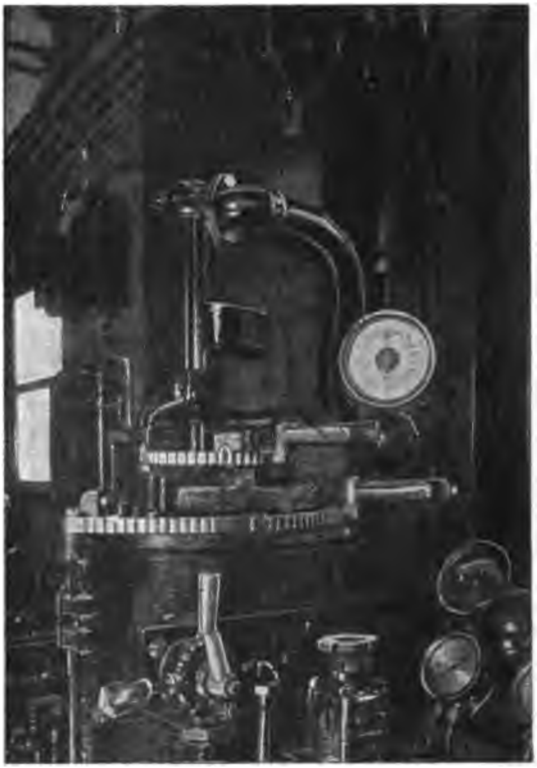
THE BEGINNING OF A WONDERFUL NEW AGE.

The achievement of the Chicago, Milwaukee and St. Paul Railway in electrifying their division that traverses the Continental Divide, extending from Harlowton, Montana, to Avery, Idaho, a distance of 440 miles is an epoch making one; it marks the beginning of a new age in railroading, in electricity, and in conservation of resources. This long and important division extends through a region of great scenic beauty,—towering snow-clad mountains, awe-inspiring canons, long ascending grades at the crest of which begin long descending stretches,—and across that entire section the mightiest electric locomotives in the world are drawing with ease, with safety, and dispatch long, heavily laden freight and passenger trains, and the motive power is derived—not from burning coal but from the energy of moving water, transformed into electricity at the great hydro-electric plant of the Montana Power Company at Great Falls, Montana.

Under normal conditions, forty-two immense electrical locomotives are required to haul trains over this division. These locomotives weigh 284 tons each and will haul 3,200-ton loads trailing up a grade of 52 feet in the mile at an average speed of sixteen miles an hour. Similar electric locomotives geared for greater speed will haul 800-ton passenger trains over the same stretch of road at a speed of about twenty-five miles an hour, and on a level stretch at a speed of sixty miles per hour. To appreciate the immense tractive power of these electrical "Goliaths" one should know that the wood-burning locomotive of fifty years ago weighed twenty tons and had a tractive power of only 5,000 pounds. The present day Mallett steam locomotive has a tractive power of 76,000 pounds, but the electrical locomotives weighing 284 tons have a tractive power of 85,000 pounds. These locomotives are 112 feet, 8 inches long, and are driven by separate motors, twin-geared to each of eight pairs of driving wheels. The cab extends nearly the whole length of the locomotive.

WITHIN THE LOCOMOTIVE.

This long locomotive body is divided in the center for greater flexibility in handling, but it is a unit, with four of its motors at each end. Just as the trolley car is controlled from either end at will, so is this locomotive, which, accordingly, requires no turn-table at division points. Within the locomotive is a maze of electrical machinery. To one uninitiated a glimpse of this interior would be absolutely bewildering, with its ammeters,—which "keep the books," or measure the current—and gauges, and speed indicators, its oil fired steam boilers for heating the train and its small motor-driven dynamos for use in regenerative braking.



Courtesy of C. M. & St. P. Railway.

WITHIN THE LOCOMOTIVE.

Some of the ingenious and effective mechanism by which the engineer controls his locomotive. Electricity is a wonderful force and easily controlled, but the engineer must not go to sleep on his job.

SUPERIORITY OF THE ELECTRIC LOCOMOTIVE.

The electric locomotive can be operated for a thousand miles or more with only casual inspection, whereas the steam locomotive on mountain work requires considerable attention at every division point. This has made it possible to operate the electric locomotive over several old steam divisions, and practically eliminate roundhouses and yards at intermediate points.

By contrasting its workings with the steam locomotive in cold weather, the superiority of the electric locomotive is notably demonstrated. In cold weather a steam locomotive, losing much of its power through heat radiation, draws lighter loads, makes less speed, and has greater difficulty in climbing grades and penetrating snow-drifts, while the electric locomotive, aided by the cold in keeping its motors cool, is able to draw maximum loads, maintain its regular speed, and, by its immense power, to drive through snowdrifts with comparative ease.

Courtesy C. M. & St. P. Railway.

HANDLING FREIGHT IN THE ELECTRICAL AGE.

No more stalling. These locomotives climb two percent grades, drawing a 3200-ton train, plow through snow drifts, and do their work more cheerfully than ever in zero weather. On a down grade they generate electricity and thus help distant train up hill.

REGENERATIVE BRAKING.

Regenerative braking applies to a method used on down grades, by which the train, instead of consuming electricity, actually produces it while traveling onward, and by which, at the same time, the speed of the train is kept under perfect control.

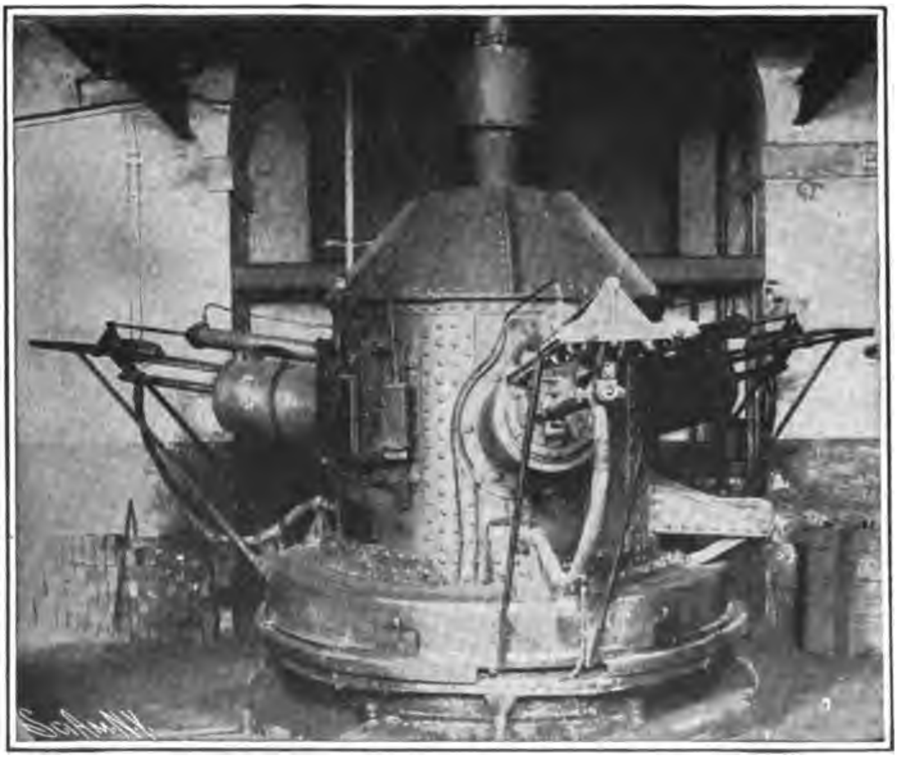
In explanation it may be said that electric motors are reversible in their function, namely: while they absorb electrical energy and give out mechanical energy going up grades, they can reverse this operation and absorb the mechanical energy given the train down grade by gravity, and transform it into electrical energy. Thus the electric locomotive provides a perfect braking system, which is independent and separate from the air brakes, which are used only in emergency and for stopping trains. Electric energy so generated can be turned into the trolley wire to assist other trains and reduce the amount of purchased electric current.

SOURCE OF THE POWER.

The source of this power is the Great Falls Hydro-electric Company located at Great Falls, Montana. The current is delivered to the railway at seven points along the lines. The current as received has to be "stepped down" and changed from an alternating to a direct current. Part of the wonderful devices in the locomotive cab effect these changes. It might be remarked that electrical power is sent from Great Falls widely over the state by many transmission lines, and the state of Montana is in the front ranks of states that utilize their water power.

MANUFACTURE OF STEEL BY ELECTRIC PROCESS.

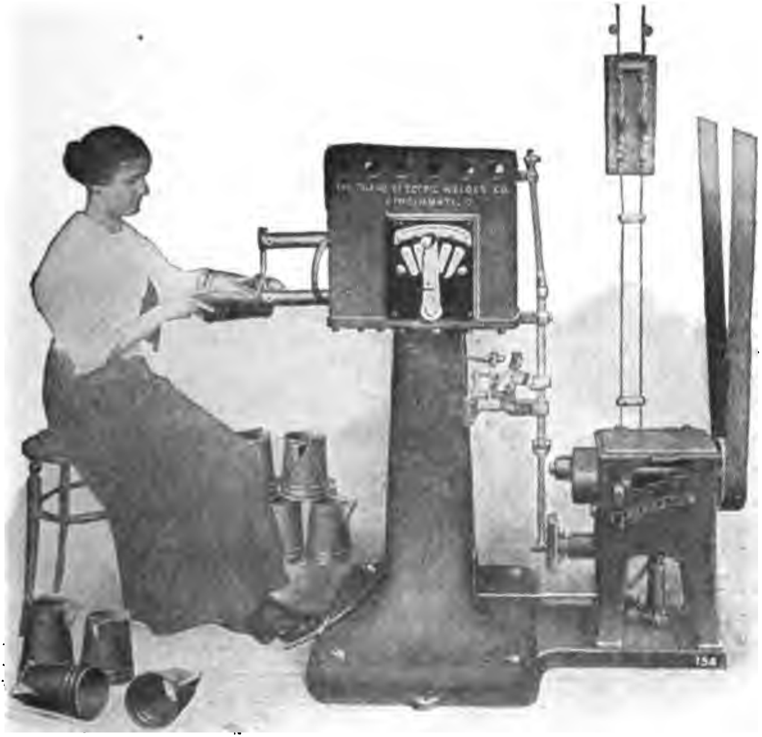
Of recent years a great advance has been made in the manufacture of steel by the use of the electric furnace process. It produces electric steel just as we speak of Bessemer



AN ELECTRIC ARC FURNACE.

There are various forms of the electric arc furnace. In this one the furnace is charged with several tons of ore or refuse steel. Two immense electrodes of carbon are suspended above the charge through which the arc passes. An extremely high temperature is readily obtained.

steel, or open hearth steel, or crucible steel. Steel produced by electricity possesses certain advantages. It is made at a very high temperature, and consequently is very fluid when it is cast, and the castings are uniform and free from blowholes and flaws. In addition an electric furnace can be constructed much cheaper than any other form of a furnace.



THE ELECTRIC WELDER.

When we formerly mentioned welding it called to mind the grimy blacksmith and his forge. The chances are this young lady is welding far more intractible metals than the old blacksmith could weld and there is nothing suggestive of hard work about it.

We can understand therefore its rapid growth in general favor. In 1906 there were but five electric steel furnaces in the United States. In 1916 there were one hundred and ten. Fifty more were built in 1917, and many others in 1918. In the most recent mills, as at the great triplexing mill at South Chicago, three steel making processes are employed,—the Bessemer, the open hearth, and the electric furnace, which is used as the finishing off process. The metal is not allowed to grow cold after it leaves the blast furnace. The principle employed in the electric furnace is that of the arc.

ELECTRIC WELDING.

The advantages of working with a current of electricity—with its enormous heat producing capacity, the ease with which it can be applied—are strikingly manifest in electric welding. By this means metals like brass, bronze, cast iron, etc., previously considered unweldable, can be readily joined. Another advantage is that shapes so intricate as to be beyond the capacity of welding by any other device or process are readily united by the electric welder. Machinery broken at sea, where ordinary means are not available, can be repaired,—as for instance, a broken propeller shaft. In the World War we were furnished a most impressive object lesson in electric welding. In our ports were a large number of German steamers that had been interned but which we desired to use as transports for men and supplies to Europe. Foreseeing such use the crews had, as they thought, ruined the machinery. It was estimated it would require at least a year's time to replace the broken parts. American engineers suggested electric welding. Almost as a last resort it was attempted. Results—the saving of a year's time and $20,000,000. A few months later those ships were carrying troops to the battle fields of France.

MAKING SHIPS WITHOUT RIVETS.

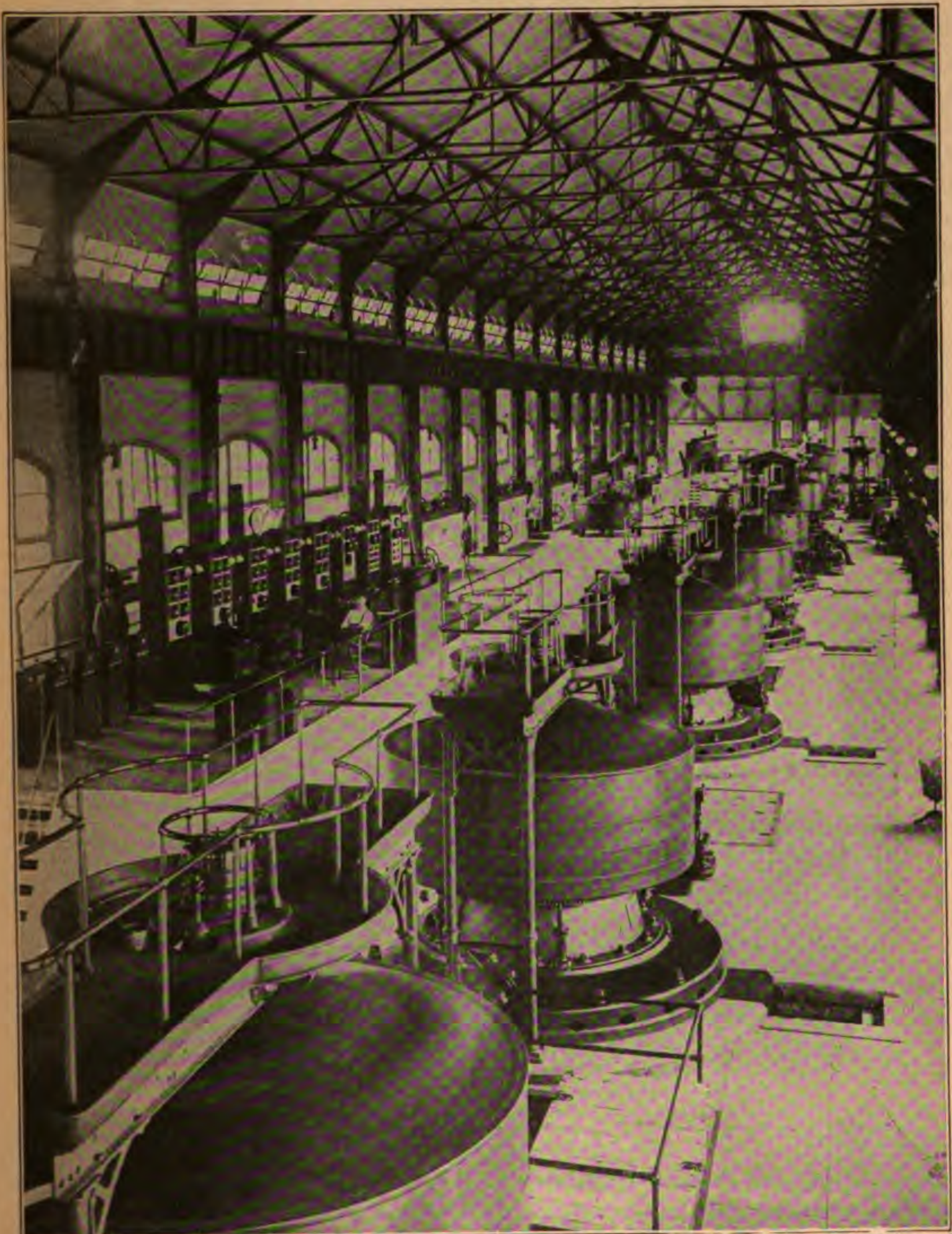
Another most signal triumph is the production of a rivetless steel ship. The United States Shipping Board has made interesting experiments in this direction; in fact, an entire ship has been constructed in which the steel plates instead of being riveted together are welded by the electric process. The advantages are of course self-evident,—. there is great saving in time and expense of construction and in weight of ship. It is estimated that about 25 per cent is saved in actual cost, in constructing some parts of the ship, the labor saving is nearly 70 per cent. On a 9,500-ton ship the saving of weight is about 500 tons, which means that the same ship could carry 500 tons more of freight.

ELECTRICITY BECOMES THE CHEMISTS' ASSISTANT.

It is necessary to mention one other department of industry in which electricity is the only force that can be employed as very great heat is required. That is the field of electro-chemistry. The production of electric steel is a practical application of this principle. The fixation of nitrogen is another. Nitrogen is absolutely essential to plant growth; there are exhaustless quantities of it in the air, but in the form of pure nitrogen it cannot be utilized. It must be reduced to some nitrogen compound. It is such an unsociable element that it will not enter into combination with other elements unless it is literally forced to do so. A very strong current of electricity will accomplish this result. Such reaction is effected at Niagara. The government has a large plant at its agricultural experiment station at Arlington, Virginia. We have just mentioned the government's enormous plants at Muscle Shoals and Charleston. It is known that Germany had been producing nitrogen for years, before the World War (and keeping still about it) for ammunition purposes. When our population has once more doubled, we will need all the nitrogen we can fix for agricultural purposes.

THE STORY OF NIAGARA.

The value of cheap electricity produced in enormous quantities is best illustrated at Niagara. When that power was first developed efforts to make artificial grinding materials, under the general name of abrasives, were largely a failure, because the expense



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NIAGARA SET TO WORK.

In this building a fraction of the power of Niagara is made to do useful work. Each dynamo represents a 5000 horsepower. It makes 25 revolutions per second, being run by turbines situated in the pit shaft below. The resulting current is sent to nearby towns, and performs all sorts of useful service. By international agreement only a certain per cent of the water can be thus set to work. The falls are impressive. They are enormously expensive if looked at in the light of dollars and cents.

of production was so great. At Niagara two abrasives are made of near diamond hardness,—carborundum and alundum,—for both a heavy current of electricity is required. The mixture from which carborundum is made requires a temperature of 1,350 degrees centigrade to be continued for forty-eight hours. During the World War our supplies of emery and corundum from Asia Minor were cut off. Had our automobile factories, munition plants, car works, and machine shops been deprived of Niagara abrasives, the manufacturing industry of our country would have been paralyzed. Automobile bearings are ground on Niagara made grindstones. Not a shell was sent to Europe whose nose had not been ground into shape by their use.

SOME OF THE STRANGE COMPOUNDS.

That is not all of the benefits derived from utilizing the electric power of Niagara. We now make more steel in this country than the entire world produced when McKinley was first elected president. Three-fourths of that steel is made by the open hearth process in which ferro-silicon (an alloy of iron and silicon) is used. That alloy is

Courtesy of Delco Light Products.

ALL THE COMFORTS OF CITY HOMES.

Only one of many practical applications of the Delco Light Products, Dayton, Ohio. By this system, electricity as effectually serves rural homes as an efficient lighting system provides for the comforts of city homes.

almost entirely a product of Niagara. Then there are other compounds made at Niagara such as calcium carbide from which acetylene gas is made. We must not overlook graphite that becomes lead for our pencils, color for ink, a base for lubricants, electrodes for furnaces, etc. This partial survey illustrates what great possibilities are latent in many streams of our land. But the on-coming electric age will be vastly richer in such productions, for nature has wonderful secrets soon to be revealed.

Courtesy of Delco Light Products.

ELECTRICITY ASSISTS THE FARMER'S WIFE.

A LIMITLESS FIELD OF USEFULNESS.

We have considered a few departments of industry in which electricity is assuming a prominent role. But in countless ways in by-paths of activity this same obedient force obligingly serves us. It is digging tunnels, quarrying marble, and mining coal; it is ready to heat our rooms in winter, or cool them in summer. In recent years it has been enlisted in rural life services. It goes to scattered farm homes and brings in its train countless conveniences. It is the farmer's first assistant; it is the farmer's wife's servant of all work, taking from her wearied shoulders much of drudgery and supplying comforts before available only to dwellers in cities. It takes its place with the telephone, automobile, and rural delivery —agents that are bringing so much of cheer to country homes that the near-by city is losing its charms.

It is not necessary to await the time when electric wires will carry to all parts of our country supplies of power, which can be utilized in scattered homes. Each home can have its own electric light and power plant. In the Delco System, recently perfected, this wonderful force generated, packed away in a most serviceable storage battery is ready to furnish power any hour, day or night, to light the home or by anyone of many services to assist the busy housekeeper. It will do anything from cleaning carpets to cooking dainties; it will churn or wash with equal willingness and efficiency. When the battery is discharged the dynamo, run by either kerosene, gas, or gasoline, quickly renews its charge.

Courtesy of Delco Light Products.

OUT OF DOORS WITH THE FARMER.

OUT OF DOORS WITH THE FARMER.

This same force goes out of doors to help the farmer in his work. It furnishes light or turns the grindstone with equal willingness. The electric light, absolutely safe in the barn, furnishes all light needed for work when days are dark or when field work is pressing and chores have to be done, more or less in the dark. No more carrying of lanterns with consequent danger of fire. Figure out what would have been saved in Chicago had Mrs. O'Leary been provided with such a light.

Then again this same willing force replaces the creaking windmill with an electric pump by which the home and farm buildings are provided with as serviceable water system as our city cousins enjoy, not requiring, however, a trip to city waterworks every six months. That service installed, the front lawn in dog-days need no longer be a dusty expanse of brown herbage with its pathetic flower beds, while hot and cold running water in the house relieves much in kitchen work and renders the bathroom a source of pleasure and health. In fact, the electrification of farm work is proceeding with quiet regularity. Electric trucks are drawing loads of hay or grain across farm fields of a size no team of horses could possibly move. Motor-driven machines are sawing wood and cutting ensilage in a perfectly satisfactory way; even an electric milker is in the field, said to do its work with neatness and dispatch.

ELECTRICITY MADE TO CARRY OUR MESSAGES.

If power were all that could be transmitted the discovery of electricity would constitute one of the greatest forward steps in the history of human progress. But this serviceable force is made the means of communication between distant points. No more important step was ever made. Thought thereby became volatile. If we will only stop to think about it we will agree that civilization, to a large degree, depends on our ability to exchange thought. Before the invention of printing, progress was necessarily slow. Using a figure of speech we may say that thought was in a solid state. Printing liquefied it. It moved readily from man to man, from place to place. The telegraph volatilized it. Now, the activities of the world are read in our morning paper.

THE TELEGRAPH

All are acquainted with the telegraph, but few realize how great has been recent advance. Stranger still it is claimed by investigators, who sometimes catch glimpses of possibilities which they have not yet made actual, that the art is yet in its infancy. The Duplex telegraph of Edison in 1872 was regarded as a wonderful thing, but that was long ago surpassed by the Quadruplex system, that is to say four messages sent or received, simultaneous, over a single wire, in no way interfering with each other. This result is rendered possible by a process of tuning, so that the different instruments respond to electrical waves of differing intensities.

AUTOMATIC TELEGRAPH.

One direction in which the telegraph has made great advance is in the use of automatic devices, which greatly increases the capacity of the wires. These methods require that the message be placed on a prepared slip, which, fed into one instrument reproduces with mathematical accuracy the dots, spaces and dashes at a distant station, by means of a receiving instrument on another slip. In the Pollak-Virag system, first used in 1907, the message was received and delivered off a strip of photographically sensitized paper. Recent tests of this system over a distance of 450 miles develop a speed of 45,000 words per hour. And even that is slow compared to the Delany system. And the principles of multiplex telegraphy may be applied to these high speed automatic devices. It is possible to send a dozen different sets of transmission over the same line.

PRINTING TELEGRAPHS.

While the Page-printing telegraph that receives messages and automatically records them in typewriting, with many lines to a page, was invented some years ago, its practical adoption has been slow, owing to certain difficulties of operation. However, a combination of some of the most successful patents has recently been made and printing telegraphs are now being regularly used on telegraph lines.

It is expected that a wide use for these telegraph instruments will be developed in business. A concern that has many branches in a city, for example, will be able to send general orders to all branches from a central office, or a factory manager may issue orders to the various departments of a large plant by means of printing telegraphs. The instruments can be connected, so that a message sent from the main office will be printed either on all the instruments of the system, or on one particular instrument only. This system has been developed rapidly. In the distribution of news, great possibilities are presented by the improved device. Its most immediate field is in the automatic transmission of messages by telegraph companies.

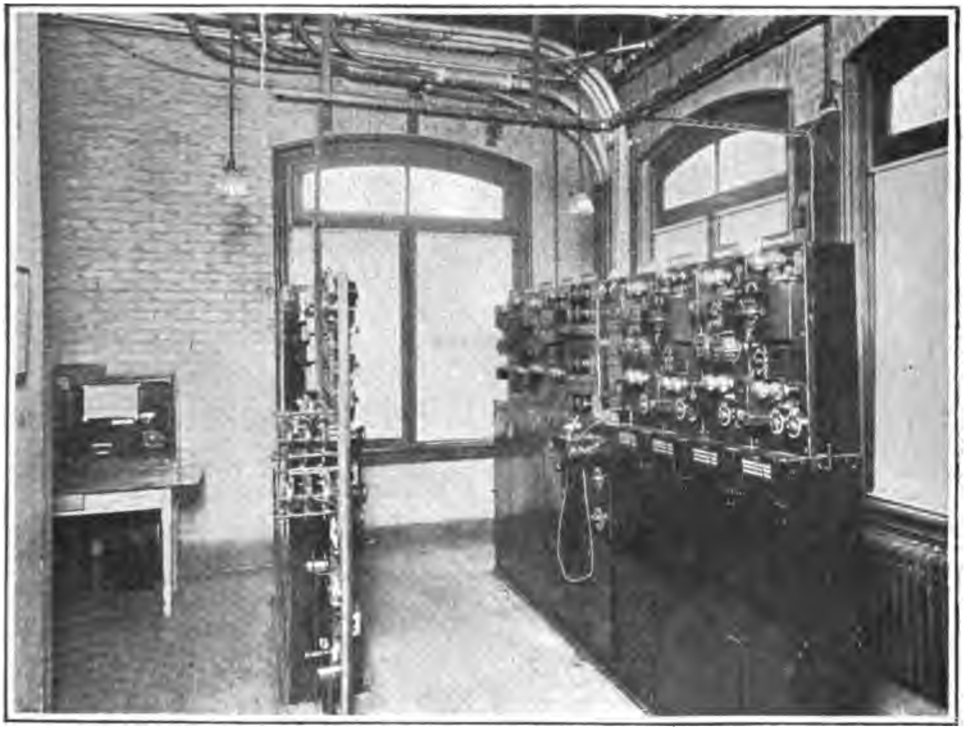
THE PAGE-PRINTING TELEGRAPH.

In its simplest from, the Page-printer will send messages at the rate of forty-five words a minute, but combinations of instruments make it possible to send one hundred and eighty words a minute in each direction, at the same time, over one pair of wires—or a total of 360 words a minute.

In sending a message the operator writes the words on a typewriter. This typewriter makes perforations on a tape, a different combination of fine perforations being provided for each letter of the alphabet and for various symbols. Each time the operator touches the space-bar on the typewriter, a separate perforation is made to record the space; when the operator reaches the end of a line and moves the carriage back to begin another line a separate perforation records that action. This tape is then fed to an instrument that sends the dots of the perforations over the telegraph line. At the other end a typewriter is operated directly by the dots, writing out the words as sent, spacing the word, and shifting the carriage exactly as was done on the original machine.

GETTING MORE SERVICE FROM THE WIRES.

A new method of multiple telegraphy, first perfected for telephone purposes, can now be used that greatly increases the message carrying capacity of the telegraph wires. This method makes use of alternating currents of high frequency. We are familiar with the use of octaves in music. Different rates of frequencies are somewhat analogous to different octaves. After many years of exhaustive research, a method has been found of using different frequencies over the same wire at the same time, using a separate instrument keyed or attuned to each individual frequency employed. On a piano a tune might conceivably be played in two or three different keys at the same time. If you can possibly conceive of a number of phonographs ranged around, so constructed that each individual phonograph will only record the tune played in its key, you will have a mental picture of what takes place in the latest improved method of wire transmission.



MULTIPLEX TELEGRAPHY AND TELEPHONY

This is a general view of the multiplex apparatus used for telegraph or telephone purposes or in combination, partly for one and partly for the other purpose. Alternating currents are used whose frequencies occupy a range between the ordinary telephone currents and in wireless communication.

A VAST INCREASE OF MESSAGES.

A single pair of wires equipped with this new system is given an enormously increased capacity. As applied to high speed printer systems eight times as much service can be secured; applied to the ordinary duplex telegraph circuits in general use they are rendered ten times as efficient. These increased results are attained without in any way impairing the telegraph traffic. It is still more wonderful to read that wires equipped with this new device can be used partly for telephone and partly for telegraph purposes. This means that a pair of wires is available either for five simultaneous telephone conversations, or for forty simultaneous telegraph messages, or partly for one and partly for the other. It needs no further comment to show the enormous value of this most recent advance.

TALKING OVER THE WIRES.

Within the life time of those now living, the world has seen the telephone develop from a toy transmitting speech from one room to another to the marvelously perfect instrument of today,—whereby we can hold conversation across the continent from Montreal to Vancouver. Now what is it that is transmitted? Certainly not sound. But what is sound? Sound is the effect of vibrations in a material substance, generally the air, that reach the ear. The problem, then, is to find some method by which the vibrations produced by talking into the receiver may be reproduced at some distant point. Electricity being such a willing slave, we have found a way in which to make it do this necessary work.

BELL'S FIRST TELEPHONE.

This scene is of historic interest. The first telephone was shown at the Centennial Exposition. Emperor Dom Pedro of Brazil is representing testing it. He expressed great surprise to hear it talk.

MECHANISM OF THE TELEPHONE.

The telephone consists of an electromagnet, or, let us say, a coil of copper wire attached to a steel bar charged with magnetism. Close to the bar is a thin sheet of iron or ferrotype. This contrivance is connected with the wire that carries the message and acts with the electrical generating device. Now when sounds are directed against the ferrotype, it causes a break in the current of electricity which is imparted to the wire. At the other end of the wire, a similar device is receiving these impulses by the alternate attraction and cessation of attraction of the plate by the magnet, and the sound is produced.

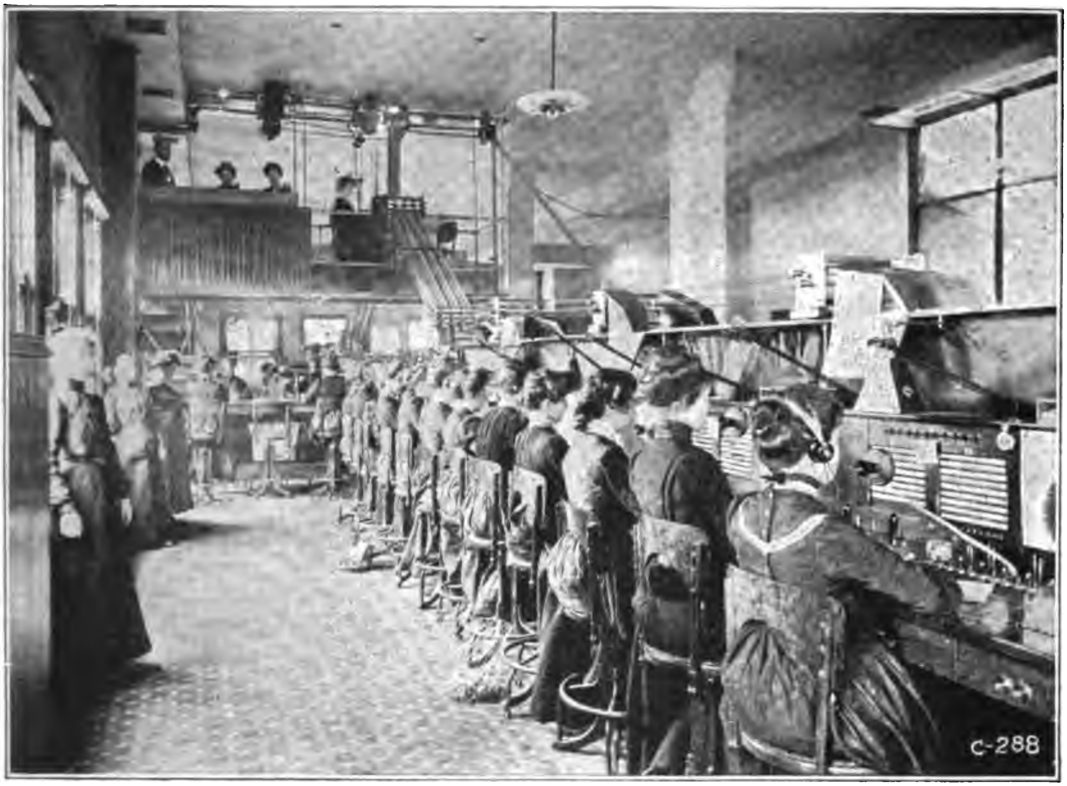
MULTIPLEX TELEPHONE.

We have seen the use of multiplex instruments in telegraphy. Only within the last few years has the multiplex system been applied to the telephone, but a system has been invented by which one is able to send ten or more telephone messages simultaneously along the line of a single wire. We say "along" the wire for, according to the inventor, the electric waves are simply guided by the wire. They do not traverse the surface of the wire as the electrical currents used in telegraphy.

The multiplex system of telegraphy—the use of different frequencies—to which we have referred, was first developed for the use of the telephone. By this system in addition to the usual telephone conversation four other conversations can be carried on at the same time, over the same wire, and in each case the service is as good as if the circuit was carrying a single conversation in the ordinary way.

VAST DEVELOPMENT.

The development of the telephone has been one of marvelous magnitude. Modern business could not be transacted without it. It is only when we stop to consider the thousand and one respects in which our business and social life would be impoverished if deprived of the telephone that we realize how essential it is to modern life, and then we understand the reason for its rapid extension. It has literally conquered the world. In large towns and cities no business has



CENTRAL TELEPHONE EXCHANGE.

This scene is fairly typical of telephone activity in any large town. The operators are receiving messages from all sections of the city. They are distributing the calls to the various sub-exchanges (if there are any) and are making the necessary connections.

been more systematized. The central exchange is the pulsating heart of the business and social life of the city. To it thousands of calls from the home, the office, stores and factories converge; from it other thousands of answering calls are dispatched.

THE TELEPHONE IN WAR.

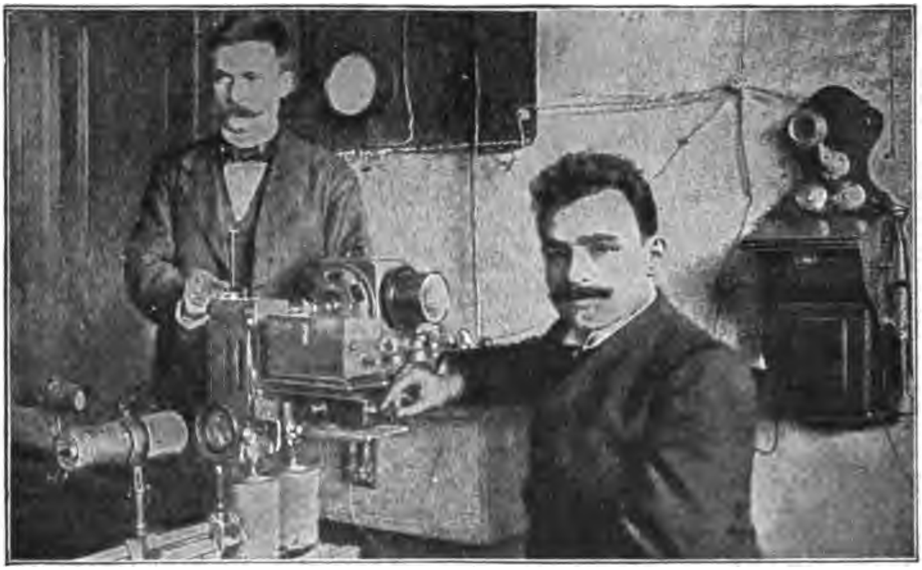
The World War demonstrated that modern warfare can no more dispense with telephones than can any other department of modern life. In a modern battle extending over possibly a hundred miles of front it is absolutely necessary for every unit engaged to be in constant telephonic communication with the commanding officers and with distant headquarters. The linemen's work on the battle front was as hazardous and as essential as that of the soldiers in the trenches. The communicating lines had to be kept open. They were the nerves by which the commanding officer was fully informed of what was transpiring and could issue necessary orders.

TELEGRAPHING PICTURES.

To telegraph a picture—say a photograph—is to send modulated light waves. Theoretically it should not present greater difficulties than to transmit modulated sound waves, and this we accomplish in telephoning. Accordingly, Prof. Korn of Munich took up the problem and has developed what is called Telephotography. He has shown it to be feasible, and in the future the process will doubtless be perfected. The photograph that is to be transmitted is placed on a transparent glass cylinder that revolves slowly, and at the same time moves from right to left, a ray of light is thrown on the cylinder by means of an electric lamp and lens, and when the ray of light reaches the interior of the cylinder, it is brighter or darker according to that particular part of the photograph over which it passes.

Inside the cylinder in some selenium, which transmits electrical currents in proportion to the intensity of the light that reaches it. Now at the other end, a similar glass cylinder is covered with sensitized paper, an electric lamp placed within the cylinder burns more or less brightly according to the intensity of the light which reaches it. Thus the picture is reproduced as the cylinders synchronously revolve.

It is surprising what fine pictures, showing a wonderful amount of detail, can be transmitted hundreds of miles. Pictures showing groups of persons, or stirring scenes, such as the "Prince of Wales, Reviewing the Boy Scouts," come out remarkably clear. This principle is even applied commercially between illustrated papers of Paris and London. A simple refinement of known means should enable photographs to be sent across the Atlantic in a few minutes time.



PHOTOGRAPH OF PROF. KORN IN HIS LABORATORY, WITH APPARATUS FOR TELEGRAPHING PICTURES.

TELEVISION.

A great many attempts have been made and patents taken out to send by electricity vibration, which would be cognized by the eye as vision, on the same principle that vibrations are sent, which are cognized by the ear as sound. Theoretically the thing is possible. Sufficient advance has been made by other methods to "see" simple geometrical designs some fifty miles distant. But if the method just discussed can in any way be hastened, so that the photograph could be transmitted in the fraction of a second instead of taking, as it now does, from ten to fifteen minutes, the result would be achieved. Such acceleration is entirely possible. Electricity pays no attention to time. All that is necessary is continual refinement of present processes and we shall have "distant vision." At present we simply glimpse a possibility, which has not yet been realized.

ELECTRICITY WITHOUT WIRES.

We have thus far been considering the work of electricity that is conducted to its work by means of wires. A wonderfully interesting department of electrical activity must now be taken up—it is the field of wireless electricity. It is a recent department of research in which very practical results have already been produced, and it presents wonderful possibilities in other directions.

The old saying is "More haste less speed," and we shall stop to consider a general outline of etheric waves, for therein lies all that is mysterious in the wireless field. Let us refer to sound waves. As all know, sound waves are waves in material substances, as we know matter, generally in the air, which, striking the ear, produce the sensation of sound. We know they divide themselves into groups that we call octaves, they differ from each other in frequency of vibration (pitch) and amplitudes. Only a few of the total octaves of such waves can be recognized by the ear. No doubt some animals are so constituted that they can hear octaves of sound that we cannot.

WHAT ARE ETHERIC WAVES?

The ether is the unknown something supposed to fill all space. There are no doubt many groups of vibrating waves in the ether. Some we have studied. Light and heat waves are familiar to all. Others we have learned something about in recent years and know how to originate them. Etheric waves, as far as known, are,—X-rays, light, heat and Hertzian waves. The X-rays are so named because the letter X stands for unknown quantities, and their discoverer, Prof. W. C. Roentgen, could think of no better name for them. The Hertzian rays are named after their discoverer, Prof. H. R. Hertz. These latter waves are the ones that produce the phenomena of wireless electrical effects. There are doubtless other groups of etheric waves that we have not yet discovered.

COMMON CHARACTERISTICS.

All these groups of waves have common characteristics. They are all etheric oscillations, they all travel through space with the same velocity, they differ in rapidity of vibration (frequency) and in wave length (amplitude). Since they traverse space with the same rapidity, it follows that the shorter the wave, the greater the rapidity of vibration. They increase in length but decrease in rapidity of vibration in the order they have been named. Hence the Hertzian waves are the longest and slowest of the series, but they are slow only relatively. They are inconceivably rapid to our senses. What shall we say, then, to the rapidity of vibrations of the X-rays? The finite mind is utterly unable to conceive of it.

THE ORIGIN OF ETHERIC WAVES.

Etheric waves of all kinds are generated by pulsating electric charges. So far as we know that is the only way in which such waves can be generated, no matter what kind you have in mind. Nature has various ways of originating pulsating electric charges. All intensely heated bodies, like our sun and other radiant suns, literally flood all space with etheric waves. The eye can see light from stars unthinkably distant; that implies that the vast distance between is pulsating with etheric waves set afloat by the distant star. Nature also generates such waves—though not of great intensity—in all cases of radio-active bodies like radium. Since all substances are, probably, at times at least, radio-active it means that etheric waves are always around us.

THE PROBLEM TO BE SOLVED.

After Hertz had discovered the waves that bear his name and had shown that they could be produced by an electrical device, research workers began to seek for some means of utilizing them for telegraphic purposes. The problem was to generate such waves at pleasure, set them going in space and invent suitable receiving instruments, which, at some distant point, would answer to them. Notice what is to be transmitted. It is not electricity itself. It is electrical energy which, carried by etheric waves through space, is to be received and changed to electricity again.

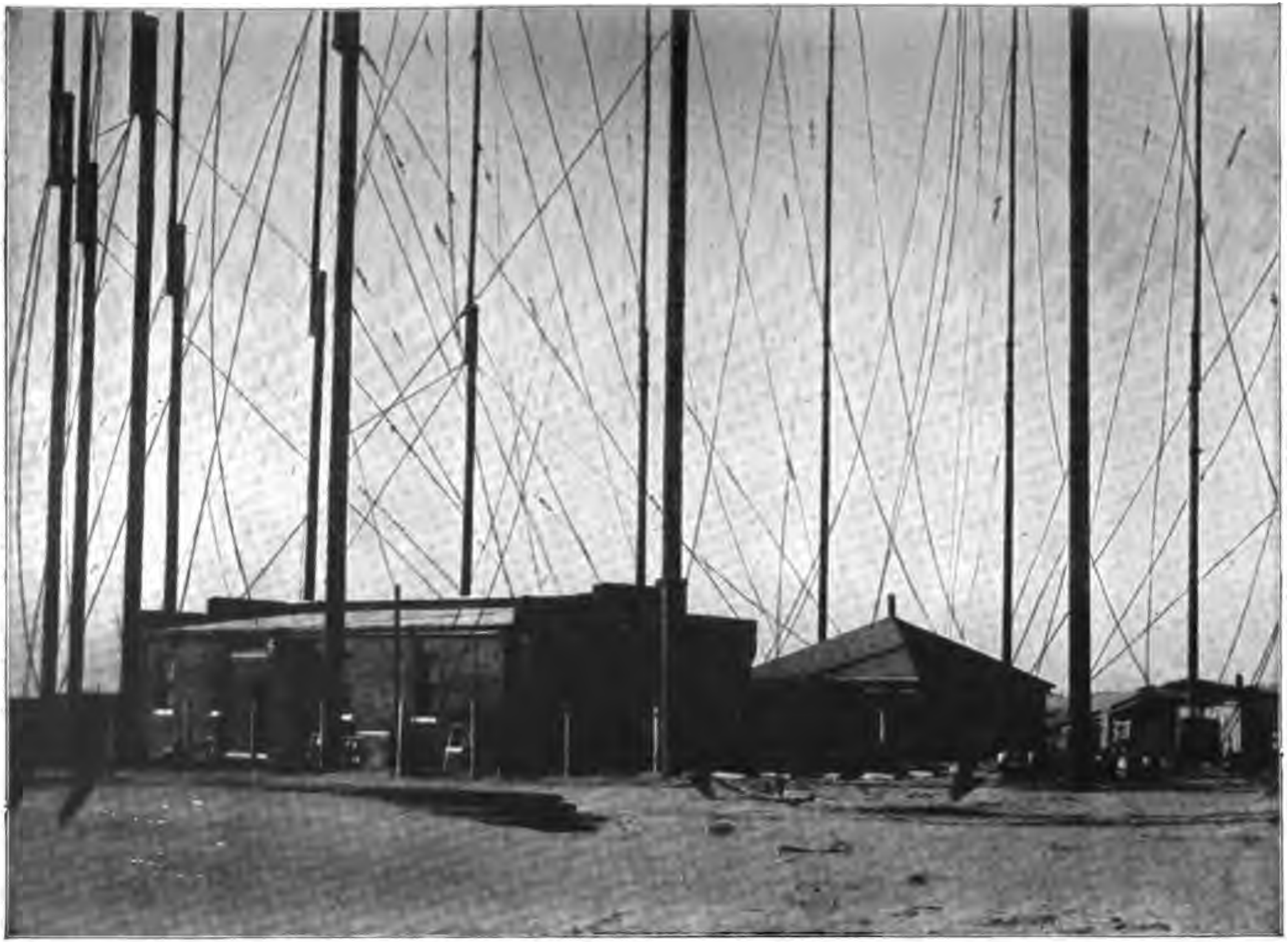
THE SCIENTIST WHO SOLVED IT.

Gugliemo Marconi, an Italian scientist, must be given the credit for perfecting the first practical wireless telegraph (1899), constituting one of the most important steps in human advance ever accomplished. He generated the waves by means of a battery, passing a succession of sparks through the ether throwing it into a succession of waves, on exactly the same principle that striking a gong sends out sound waves. He radiated them into space from a wire suspended from a tall pole or mast.

Since Marconi's first invention we have seen a flood of improvements, and the process has been greatly perfected, but progress will still continue, future systems will doubtless surpass present methods. We now operate with immensely stronger currents than Marconi had at his command when he commenced his work. We can hold conversation with stations on the other side of the world. Not a vessel in our navy—or that of any other power—not a passenger-carrying steamer on the sea, but is equipped with a wireless outfit. Wireless stations are scattered all over the world. Our government—by its immense stations in Panama, Hawaii, and the Philippines, in Alaska, at several places in the United States—is in instant communication with all parts of our national territory, so that not a ship of our navy or force of our army is beyond the reach of

GUGLIEMO MARCONI.

He must be given the credit for the first practical application of wirelesss methods for telegraphic purposes, the first step in an electrical development whose end we cannot foresee.



MARCONI WIRELESS TELEGRAPH STATION.

At such stations on the Atlantic coast, one of which is at Poldhu, Cornwall, the southwestern extremity of England, one in Nova Scotia, and one at Cape Cod, Massachusetts, the messages are received and transmitted and the experiments carried on. The masts are 210 feet high, and twenty of them are used in a fully-equipped station.

headquarters at Washington. The same is true of other nations. England, by its stations in Egypt, India, Singapore, South Africa, and British East Africa has welded closer the tie that binds her great empire. All South America is linked up with the United States. At Buenos Aires an immensely powerful station places the city in communication with the United States.

IMPROVED METHODS.

As in the case of the telegraph and telephone the first wireless instruments are crude indeed compared with present methods. The spark method of wave production gave place to the arc generator in which oscillating currents of high frequency and great strength are used to send quivering ether waves through space, and for many purposes this has been succeeded by the vacuum bulb.

Courtesy, Pan-American Union.

SCENE IN THE STRAITS OF MAGELLAN.

Even at this distant point there is found a wireless station. It is in communication with the principle cities of South America and thus with the world.

However important ocean cables may be, they are no longer the sole means of communication between continent and continent. Over the ocean, not less than under it, space is conquered by this wonderful force—electricity.

A few years ago only fifty per cent of the energy raised was utilized, today 75 per cent is made do effective work, tomorrow will approach the 100 per cent possible. The receiving instruments are made far more sensitive to weak currents. More sensitive detectors are used. The coherer of Marconi's early system discarded long ago was succeeded by the magnetic detector, that by the thermionic device, now the oscillating valve is much used. Recent facts seem to prove that the tall masts of early experiments, still employed, are not essential. Amateur operators in New York with no masts were detected in wireless communications with Germany, or cut in on messages sent out by stations in the Mississippi Valley.

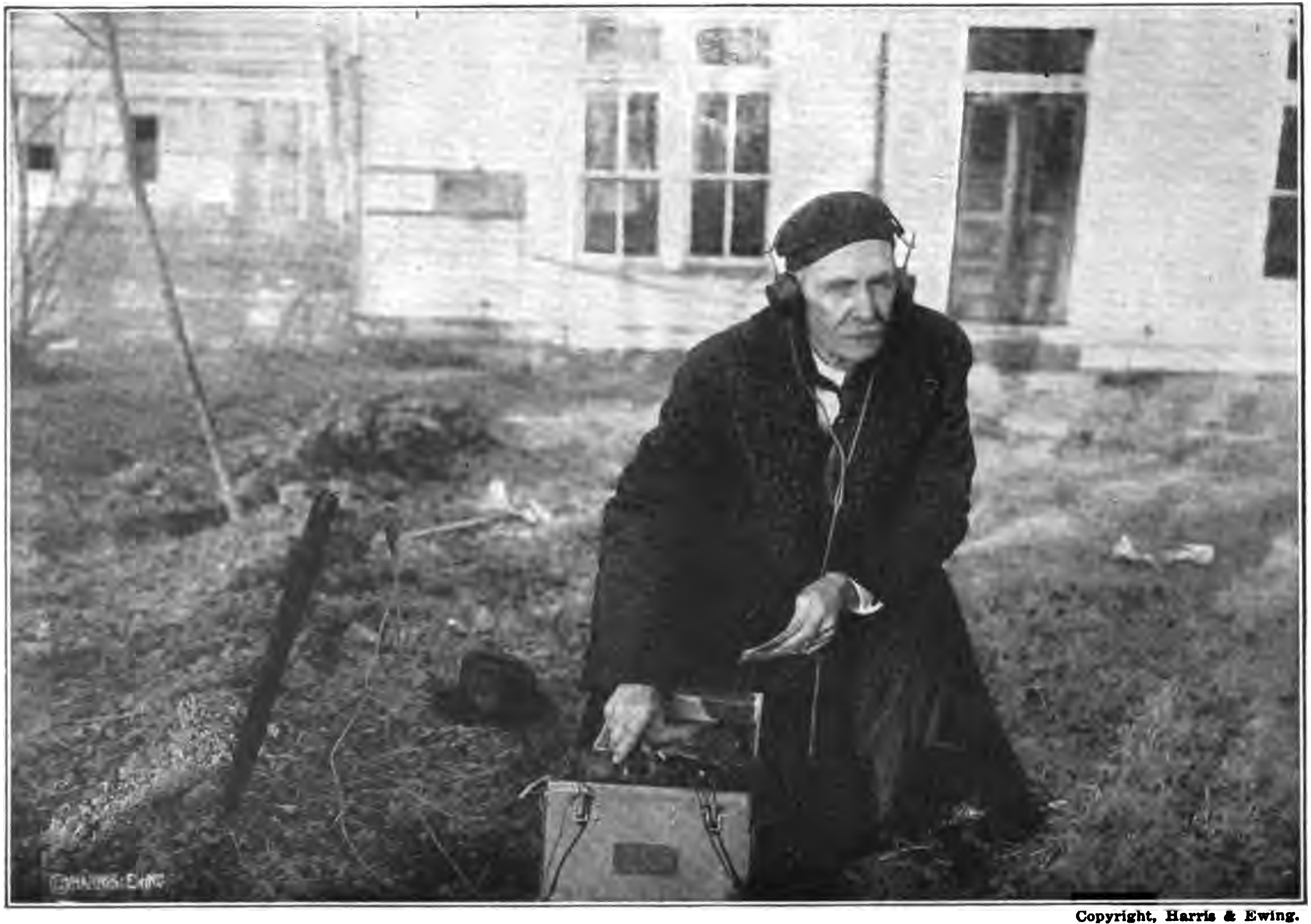
A WIRELESS CALL TO ALL NATIONS.

It was inspiring to read the wireless call to all nations informing them of the formation of a constitution for a League of Nations. As soon as adopted at Paris it was sent on pulsating etheric waves to all lands and people. The great wireless station at Lyons, France, at once sent it to Vladivostoc, Omsk, Peking and Shanghai. It was sent from San Francisco to all ships at sea, to Honolulu, Alaska, and Tokyo. It was also wirelessed to all South American and African points, Australia and the East Indies were fully informed. So all the world was informed by wireless methods within an hour of its adoption. A new world order and a new world method ushered in a new world age.

UNDERGROUND WIRELESS.

In January, 1919, a process of underground wireless was made public. As a war secret it had been in use by the navy. Briefly this invention opened up startling possibilities. It is regarded by experts as the greatest forward step since Marconi demonstrated the possibility of wireless telegraphy. It revolutionizes our former concepts, greatly reduces the expense of wireless communication, and improves the service. Static troubles and interference have been eliminated, and it increases the audibility of signals. Some of the results officially vouched for seem almost unbelievable. At the Great Lakes station, near Chicago, this system picked up messages from Nauen, Germany; Lyons, France, and from the Philippines, more than 8,000 miles away, with perfect distinctness.

During the war, the station at Belmar, New Jersey, was equipped with these receiving instruments, and it was estimated that its capacity was doubled, not a single word of communication was lost during the reception of thousands of important official messages from Europe. The older theory was that the Hertzian waves, radiated through space from the elevated masts were absorbed on striking the surface of the earth, as light waves are. Mr. J. H. Rogers, the inventor of this process, thought differently. He argued that the earth itself was a better conductor than the air, and that the electric waves would be transmitted through it. He has proved his theory right. They will go through water as well. It was stated by high authorities that for a submarine to receive wireless dispatches it must come to the surface. But by this process American submarines off our shores, while submerged, easily picked up Nauen, Germany. In the case of submarines, transmission processes have been perfected. When this process shall have been perfected for telephonic purposes, an instrument not greatly different from the pocket wireless shown in our illustration should, theoretically, enable one to telephone to one's home wherever one may be. This invention is a wonderful illustration of the steady advance of science when once the human mind is aroused.



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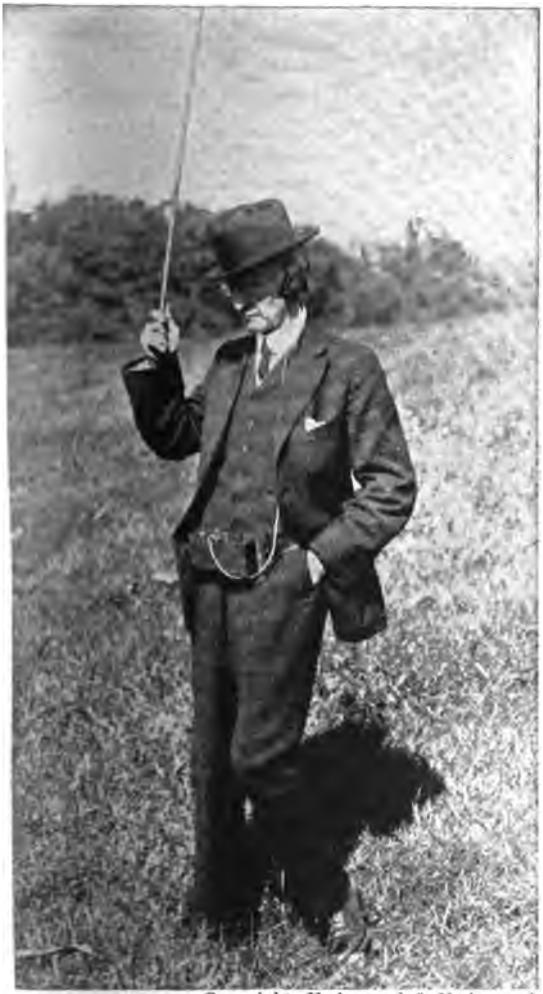
RECEIVING MESSAGES THROUGH THE GROUND.

James Harris Rogers and his portable outfit for receiving and conveying wireless messages by under surface routes. It only requires a few moments to place his device in position and thus "cut in" in messages sent from other stations. Startling possibilities are foreshadowed in this device.

THE WIRELESS IN WAR.

The European War demonstrated the great value of wireless methods in war. In the first place, the movements of all naval vessels wherever they were, were controlled by their several governments by wireless. In this way, Germany was in communication with her submarines. All their Zeppelins were fitted out with wireless outfits. By this means one huge Zeppelin, dispatched to South Africa with medicine and ammunition, was halted over the highlands of Abyssinia and ordered to return to Germany. Many airplanes were also fitted with wireless and could instantly communicate with headquarters giving details of importance. The only way Germany had of communicating with America, Mexico and other neutral countries was from her high-powered wireless station at Nauen. Every armp corps on both sides was in wireless communication with headquarters. The details for the meeting of the armistice commissioners at Senlis, France, were arranged by wireless methods.



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THE POCKET WIRELESS.

This wonderful little instrument is capable of sending and receiving messages a distance of eighteen miles. The apparatus can be carried, strapped about the waist, or hidden in a capacious hip-pocket, occasioning no particular inconvenience. What appears to be a serviceable cane, when raised, becomes the receiver.

SPEEDING UP THE WIRELESS.

Recalling the wonderful speed attained in automatic telegraph systems, it is interesting to learn that experts are "speeding up" the wireless, and they can see no reason why wireless methods should not undergo a development similar to that of wire telegraphy. The problem is to discover some chemical which will change color under the action of minute electrical discharges. Duplex wireless telegraph is effective, that is sending two wireless messages from the same mast simultaneously. Quadruplex and multiplex systems are entirely possible. It is necessary to make use of instruments sensitive to different wave lengths. It is a problem of selectivity. Each message must be individualized so there will be no interference.

RADIO TO THE STARS.

Marconi, the inventor of wireless telegraphy, has recently voiced a train of thought that may strike some as being the very acme of phantasy. Yet his conception of wireless telegraphy was doubtless so considered before he proved its possibility. Hertzian waves, like sound waves, circle out in all directions from the starting point. If waves can be sent 6,000 miles over the earth's surface they will go that distance directly outward in space. How much farther might they go? Suppose we were to employ vastly greater power in our sending machines,—and it must be added we are doing this every day,—the waves would extend farther and farther outward in space. Do they not come from the sun to the earth? Do we not in electric arcs raise a temperature approaching that of the sun? That means electrical energy approaching that of the sun. What limit shall we place to our power in this direction? Why should they not pulsate out, say, to Mars. If then Mars should chance to be inhabited by intelligent beings—and that is entirely possible—it might be that they already enjoy the use of electrical instruments of greater fineness than ours. Why should not such instruments respond to impulses from the earth? In other words, why might it not be possible to communicate with such people? Of course there may be no intelligent life on Mars. Granted that, however, there is not a query in this chain that can be denied an affirmative answer. Should such a result ever come to pass, it would constitute an event no more wonderful from our present standpoint than would, to some philosopher of the days of Galvani,—surprised at the twiching of frog legs,—have appeared a prophecy of the wonders of the present stage of electrical development. It is possible that this great inventor has given

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FIRST WIRELESS TELEPHONE.

The first wireless telephone constructed is still an effective machine, capable of sending and receiving the sound of human speech, transformed into electric vibrations of varying strength, over a wireless distance of 500 miles. Further improvements in mechanism and methods enable us to extend greatly that distance. Theoretically, it is possible to send a whisper around the world. Recently a visiting statesman was entertained in a Western city by listening to the roar of the Pacific and the gentler response of the Atlantic at the same time, a result rendered possible by wireless connection with San Francisco and Boston.

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TALKING WITH PRES. WILSON WHILE HE WAS IN MID OCEAN.

Secretary of the Navy, Daniels, is here shown talking with President Wilson when the latter was 700 miles out on the Atlantic. Ordinary telephones were used from Washington to New Brunswick, then the message was automatically changed to a wireless message, and as such caught by a telephone on the ship and thus reached the President.

utterance to a golden prophecy that the future will verify.

NOW WE TALK THROUGH THE AIR.

Since we have means of sending electrical energy through space which we utilize in telegraphy, why can we not perfect some means of wireless telephony? Theoretically there is no reason, but in working it out we came upon a difficulty that for years prevented a solution of the problem. The Hertzian waves with which Marconi initiated wireless telegraphy are easily damped out, that is they lose their energy rapidly and their frequency is low. Wireless telegraphy only interrupts the current one or two times a second to make dots and dashes. But to express the modulations of the human voice requires a vast number of variations each second. Accordingly, wireless telephony was impossible before we learned to send undamped currents of a very high frequency. The difference between a damped and an undamped current may be illustrated by beating a gong, first with a padded hammer and then with the hammer stripped of its coverings. The one is damped, the other is undamped.

STARTLING SUCCESS ATTAINED.

As we have seen in improvements of wireless telegraphy both of the above named requirements were finally attained, and then came wireless telephony. Several other delicate electrical instruments were invented, such as the audion which increases the frequency of the current, and extends the amplitude, the effect is to render the current better able to respond to the modulations of the human voice. It is useless to attempt to give explanations of the method. That belongs to technical books. It is sufficient to say that telephone experts conducted exhaustive research extending over years of time. Success of a really startling nature came to them in 1916. It is now possible to speak from the wireless station at Arlington, Virginia, to Paris, France; Hawaii, or to Panama. The voice is heard —or rather, the modulations carried over— a distance of 5,000 miles, through the ether of space, as distinctly as in an ordinary telephone conversation with one's neighbor in the next block. Since this distance would enable all the capitols of the world to converse with each other we can glimpse somewhat the importance of this new invention in days to come, when peaceful activities replace those of war.

IN CONNECTION WITH ORDINARY TELEPHONE.

But that is only half of the story. A message sent from New York over an ordinary telephone wire to the wireless station, can be automatically turned into a wireless message and complete its journey of hundreds or perhaps thousands of miles, there to be received by another telephone wire and reach its destination in some office or factory. During the war naval officials in Washington talked from phones in their office, through the wireless station at Arlington with naval vessels out on the Atlantic. Nothing is to hinder a great importing firm in Chicago from calling up, by their desk phones, their representative who is on a steamer in mid-ocean, and arranging further details of their business. Few us of would feel able to pay the toll bill, however. It is interesting to record that the secretary of the navy using the phone on his desk, talked with President Wilson, when the latter was in mid-ocean, returning from Paris. The message was automatically transformed to a wireless message at New Brunswick.

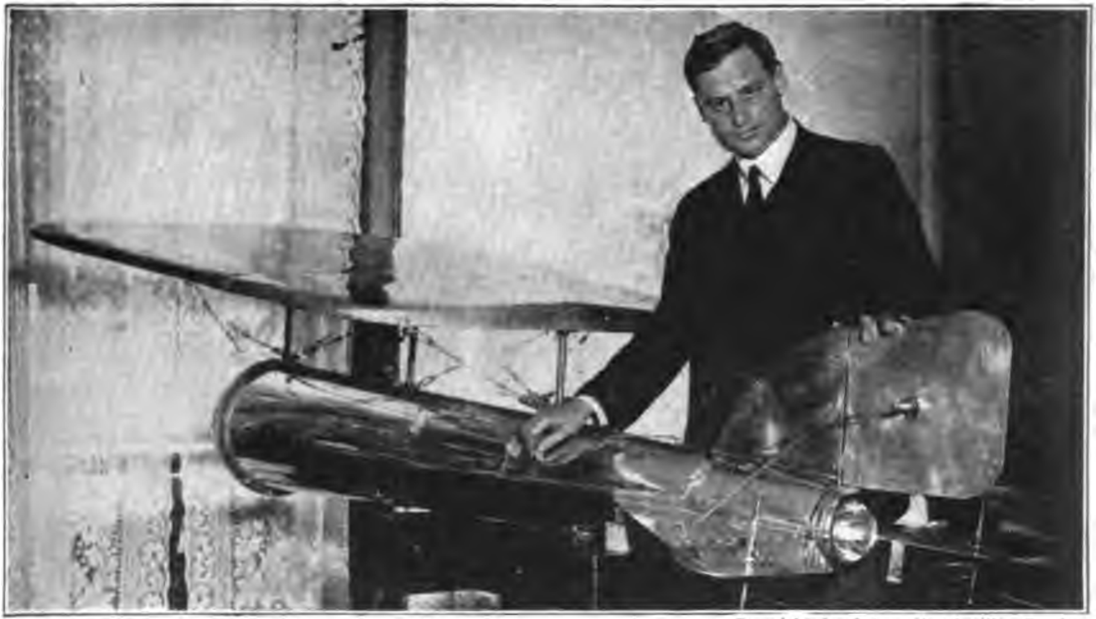
THE BONES OF A HAND AS SEEN BY THE X-RAY.

FURTHER IMPROVEMENTS.

No invention of this importance, no matter what degree of success attends its first presentation, remains for any length of time in its first stage. Other inventors are ready with improvements. We have no inventions of spectacular interest to mention, but for short distances wireless telephony is an everyday occurrence. Pilot boats and motor launches off shore are talking with their friends. The year 1919 opened with the announcement that army officers from a comfortable office could, by phone, direct the maneuvers of the airplanes circling above them. In days to come, when airplanes are carrying mails, or persons in a hurry to get somewhere over land, or excursion parties are on their way to visit Paris over the ocean, hurrying along two hundred miles an hour, their friends at home can call them up to acquaint them with important matters that have transpired.

WIRELESS TRANSMISSION OF POWER.

If whatever effect we can secure by wire conducted currents, we can also secure by wireless methods, then we should be able to transmit power through the air without wires any desired distance, and set it to work at some desired place. Whatever is theoretically possible, is possible, to a degree, at least, practically. At present we are only on the threshold of this great advance. It is now in the tentative, experimental, hesitating stage of development; but a beginning has been made. Clocks are being run by wireless. Bells on ocean buoys are made to ring from decks of passing steamers. A railroad locomotive has been operated without an engineer in the cab by wireless methods. In the illustration we see an aerial torpedo whose flight is controlled by wireless. J. H. Hammond has made a successful radio invention by which he can control the movements of a surface boat to be sent laden with explosives against enemy ships. This invention was thoroughly tested by United States navy officials who stated that from a station on shore they ran the craft all around vessels coming into the harbor at will. It will also control the movement



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THE RUSSELL AERIAL TORPEDO.

A torpedo not fired from a gun on the surface but from an aeroplane or Zeppelin. It weighs fifty pounds and can travel with a speed of 150 miles per hour. Its flight is controlled by wireless from the sending machine. The currents liberated by throwing switches on that machine deflect the torpedo to the right or left, up or down, by influencing the steering attachments of the distant torpedo.

of submarines provided any antennae show above the surface.

In these days, one invention crowds upon another. An airplane has been perfected that can be sent against a distant point—say an enemy's city a hundred miles or so distant—its flight controlled by wireless methods, made to drop its load of bombs and explosives when over the city, and return to its starting point, no pilot being in attendance.

SETTING FREE LIGHTNING FLASHES.

A very serious aspect of the transmission of wireless power here discloses itself. Like the imprisoned geni of the Arabian Nights, we may find it difficult to control. Wireless waves speed out in ever-widening concentric spheres, and so unless some vastly improved method of guiding and directing such discharges be discovered, attempts to send by wireless methods, currents of such great intensity as are now sent by wire from, say Niagara Falls, would amount to setting free lightning flashes, working mischief over wide areas. So that some method of directing the current on the same principle that light waves are brought to a focus and projected in one direction, must be perfected.

TO DETERMINE THE DIRECTION OF WIRELESS WAVES.

Owing to the nature of the propagation of wireless waves it is impossible to determine without special instruments the direction they have come when first received. It is often necessary that such direction should be known and various means are employed for that purpose. The United States Signal Service has perfected a radio-direction finder and we are told that it affords positive information and enables an airplane pilot to locate his position with respect to two or more beacon land stations that we are sending identifying signals to guide him on the way. It is said that it works with remarkable precision. Then we have the Bellini-Tosi system of directive wireless telegraphy. These experts have invented what they call a Hertzian Azimuth compass. One of these instruments, at a distance of fifty miles, will show within one degree the actual direction of the reception of a wireless message. A lighthouse supplied with a wireless equipment can acquaint a ship even in a fog with the direction of a dangerous rock or reef; but that is not all, for Marriott has devised a method of telling the distance, so ships in darkness and fog can tell the direction they are from each other and the distance they are apart.

THE PROBLEM OF CONTROL.

The mere fact that wireless vibrations speed out in ever-widening concentric spherical surfaces makes it a problem of control, requiring government supervision for wireless operations. Let us consider the following facts. In the United States alone within the last few years, practically every vessel of our navy, including those in the revenue service, have been equipped with wireless apparatus. To communicate with them, the naval department has erected a chain of coastal stations reaching from Maine to Alaska, one of the most powerful being in the Canal Zone.

These numerous stations are not only for the control of our naval vessels, but they furnish daily a vast amount of information for the use of ocean commerce, weather signals, storm warnings, the location of dangerous derelicts and other hydrographic information. The importance of this service is shown in the case of the revenue cutter Gresham, which in one day saved twenty lives from sinking schooners along the New England coast. But often commercial stations are erected in near proximity to naval stations. There are hundreds of thousands of amateur stations, so without some form of supervision there is liable to be chaos in the ethereal world. It is necessary to have government license and control of wave lengths used.

JAMMING THE ELECTRICAL WAVES.

This term came into use during the World War. Considering the vast amount of wireless service during the years of warfare we can understand that efforts would be made, on both sides, to throw the surrounding ether into such a confused medley of waves that no coherent message could be sent. Perhaps they would use an instrument, or several of them, constructed on the principle of the siren, sending forth a jangle of waves of all conceivable lengths so as to interfere with all classes of waves. The trouble was that such instruments exercised a sort of boomerang effect for whichever side employed them, found their own messages destroyed as well, still for countless reasons operators often spoke of the waves as being jammed, by analogy, probably, from the jamming of their machine guns.

WIRELESS TELEPHONING BY A BEAM OF LIGHT.

In the illustration (over) is represented another form of wireless telephoning. We are using a beam of light instead of a Hertzian wave. But we should reflect that light waves are similar in kind to Hertzian waves,

THE PHOTOPHONE—THE LATEST SCIENTIFIC MIRACLE.

Telephoning on a Ray of Light Without Wires.

both are due to electrical disturbances in the ether, and therefore we should be able to produce results of a similar nature. The transmitter consists of a plain mirror so arranged as to reflect the light upon a selenium cell in circuit with an ordinary receiver at the opposite station. The mirror serves as a telephone diaphragm, a resonating chamber and mouthpiece being placed at the back. Speaking in the mouthpiece vibrates the mirror, the vibration alters the intensity of the beam of light. The changes in the light beam result in the selenium cell (acting with its well-known property of altering its electrical resistance under influence of light) setting up corresponding changes in the receiver circuit, and so producing vibrations in the receiver diaphragm like those communicated to the mirror of the transmitter. This process has not been perfected but theoretically it would be impossible to combine it with the heliograph and obtain results of value.

THE MYSTERIOUS X-RAYS.

We have seen what practical results followed the study of the Hertzian waves. Light and heat waves are also etheric waves, and are both in their origin, the results of electrical disturbances, they differ from each other and from the other classes of etheric waves only in their frequency and length. We are familiar with these waves because we have been endowed with end organs that are affected by them. We have eyes to receive and answer to light waves; we have the general sense of feeling that responds to heat waves. We have no sense organ that responds to the Hertzian waves or the X-rays. There are doubtless other etheric waves of which we know nothing definite as yet.

NATURE OF THE X-WAVES.

In an army we can study the work of an entire army corps, or that of a smaller unit —say a regiment or a company. Finally we have the activities of the individual soldier. On the march, the army corps, the regiment or the individual soldier are all moving with the same speed, but each unit has a work of its own. In a crude way that represents the army of etheric waves, mobilized by electricity to do work in the universe of things. They all move through space with the same speed, each group has class characteristics and performs different services. The Hertzian, heat and light waves may be compared to the larger forces; the X-rays to individual soldiers, the latter are waves set in motion by moving electrons, which may be considered as the unit of negative electricity. Try and grasp this mental conception. It is not stated in scientific terms, but in a crude way it expresses scientific conclusions of deepest importance.

ORIGIN OF THE X-RAYS.

Nature originates the X-rays in abundance. They come with other etheric waves from all glowing stars, and in a quieter way all substances, at times at least, under special circumstances emit them. All radio-active bodies emit them, and consequently uranium, radium, thorium, etc., send them forth in unending streams. We can produce them at pleasure by a simple electrical machine. Briefly, if a current of electricity be sent through a glass tube from which the air is exhausted, a stream of electrons—the units of negative electricity—rush with the velocity of light from the cathode (negative) pole to the positive pole. If, now that stream of electrons be interrupted by a thin plate of some metal, generally spoken of as the anti-cathode, etheric waves, that we have agreed to call the X-rays, are at once excited and speed out like all etheric vibrations, in concentric circles. The atoms of the anti-cathode are struck by the electrons and vibrations circle out just as sound waves do when you strike a gong.

THEY BECOME THE SURGEON'S FIRST ASSISTANTS.

These waves are extremely short and vibrate with extreme rapidity. It is quite useless for the finite mind to attempt to comprehend these magnitudes. The nearest approach to them are light waves, just beyond the limits of vision. That is light waves so fast that the human eye cannot see them. In fact, X-rays are a kind of light waves which the unaided human eye cannot utilize, but the artificial eye of the camera can. Glass is transparent to ordinary light waves. Many other substances are transparent to these waves. This is the characteristic eagerly seized by the surgeon since by its aid he can secure photographs of the bony framework of the body and can detect the presence of foreign substances.

THE DEVELOPMENT OF X-RAYS PHOTOGRAPHS.

Our illustrations show how invaluable the X-ray photographs are to the surgeon. It is evident at once that the nature of fractures of all kinds can be clearly shown. The bones of the foot are shown even though a shoe protects them. If anything has gone wrong with bones or arches of the feet, the trouble is indicated. Or notice the X-ray photograph of the hand. You can see the shadowy outlines of the tissue that surrounds the bones. Notice the ring on the third finger. Evidently the metal and the bones offer more resistance to the passage of the rays. It is at once evident that the X-rays are of great value to the surgeon. Equipped with a simple X-ray apparatus dislocations and fractures are detected, diseases of the bones are studied; and shot, needles, bits of glass, or corroding wire within the muscles of a patient are located with exactitude. Who can estimate the value of such machines in the hospitals during the war? In millions of cases they were relied on to determine the nature of the injuries received in battle.

GREAT VALUE IN DENTISTRY.

X-rays are proving of great value in dental work. The teeth are among the most important part of our anatomy. As a general rule they are neglected; we are now learning that in more ways than one the health of the entire body depends on the health of the teeth. Ulcers at their roots may be poisoning the whole body. Now we carefully explore the mouth by X-rays to see if we cannot locate the seat of mysterious aches and general ills. And X-rays views are frequently, even generally, taken to determine whether offending molars should be extracted or treated and repaired. Thus another field of usefulness has been found for these rays deemed at first merely a subject of curiosity.

IN THE HANDS OF THE PHYSICIAN.

The same means of bodily exploration is of utmost value to the physician. In demonstrating the calcification of arteries and aneurysms of the heart or the first part of the aorta. It is possible to study fatty degeneration of the heart and of the larger blood vessels. The minutest movement of the heart and lungs and the least change in the action of the diaphragm can be watched and studied at leisure in the living subject. Thus it is that in operative surgery and medicine of this century the X-rays take a high place.

X-RAYS AS A THERAPEUTIC AGENT.

These serviceable rays have demonstrated that they are something more than a mere exploring force, a detector of hidden ills; they are remedial agents as well. They have been found useful in many forms of skin diseases, such as lupus. Many such cases are benefited. Many varieties of cancer, especially in their earlier stages, have been helped. They have been applied to tumors in different parts of the body and to swollen glands. Recently there has been an increased use of the X-rays, in all diseases located in one place, due to bacterial growth. An interesting conclusion is drawn from recent researches in this direction. The X-rays do not act directly on the bacteria that are causing the trouble but in some way they stimulate the surrounding tissue so that it is enabled to effectively resist the disease producing bacteria. This points to some connection between the X-ray form of electrical energy and the forces of life. Is life also an electrical phenomenon?

NATURE'S SECRETS STILL TO LEARN.

We have considered only a few of the great triumphs of recent times in the field of electricity. New and startling discoveries await us in the near future. Progress has by no means ceased; inventions, some of great moment, literally crowd each other. There is one problem awaiting solution of surpassing importance. This is the direct diversion of the energy confined in coal into electricity. At present we burn the coal, with the heat run engines, which in turn generate electricity. Theoretically, we should be able to make the conversion direct without the intervention of machinery and loss of energy. Nature shows us in the glow worm and the aurora that it is possible to produce light without heat. At present we waste about ninety-eight horsepower of energy to secure two horsepower to be used in electric lighting. Theoretically, we should be able to secure nearly fifty times as much energy.

Within the last few decades we have learned of two new groups of etheric waves, and we have discovered means of making them of great, inestimable value to man. There are doubtless other sets of wave vibration awaiting discovery that may unfold possibilities of good exceeding any of those now known. Some of the most prominent scholors of the day are studying these problems, and some day their efforts will be crowned with success. And with the coming of that day a new industrial age will open utterly surpassing the triumphs of the present. The real electrical age is in the future. We cannot forecast it, but judging from what has been accomplished, realizing that we are only on the threshold of Nature's bounteous storehouse, we may venture to prophesy of an advance greatly surpassing what has been accomplished since Franklin flew his epoch making kite.

WHAT IS ELECTRICITY?

We have been considering some of the wonderful results following the practical application of electricity to the needs of modern life. Since electricity is such a wonderful something that has such a direct bearing on modern life, and, seemingly, is to be of increasing importance in the future, it is not out of place in a volume of this nature to set forth certain conclusions concerning it that seem in accordance with known facts, and are held by eminent scientists. We shall have to state them in non-technical language, and all statements must be held subject to change as future knowledge may require; just as theories of a few decades ago have gone into the discard, so may these, but for the present they are of interest.

NEGATIVE ELECTRICITY.

While retaining much of the nomenclature of other days, we have discarded the conclusions themselves. We seem able to make a few statements concerning negative electricity. It is composed of electrons, and electrons seem to be the active elements comprising the atoms of our early text books, they also exist in a free state, they are the meteors, planets, and planetoids that compose the solar system of the atom. We know their size as compared with the size of the entire system of the atom. It is about one one-hundred-thousandth of that of an atom. Its density is, however, vastly greater than that of an atom. We think we know their general shape—spherical—and that they are symmetrical in every way. So far as we know all electrons are exactly alike. A current of electricity in a wire is a stream of electrons moving through the relatively large spaces between the atoms or through them. As far as we know negative electricity is the only kind of electricity we can move about. It is only necessary to add that the electrons seem to be nothing but energy in motion. Statements on previous pages concerning the production of electricity and making mention of electrical currents are now to be taken as statements regarding negative electricity alone. However, in radio-active bodies positive electricity is escaping from the positive nucleus or sphere.

POSITIVE ELECTRICITY.

Positive electricity seems to be an utterly incomprehensible center of force. It is the binding force of the atom that holds the electrons in their orbit. According to J. J. Thompson it is a sphere of force as large as the whole atom within which the electrons are arranged. According to others, it is the central sun, the nucleus of the system, holding by its attraction the revolving electrons. In either case the mind reels in trying to form a mental picture of an atom. Whichever conclusion be finally adapted, we seem to be dealing with energy alone.

STARTLING CONCLUSION.

We have just seen that atoms are built up by the combination of negative and positive electricity. But atoms unite to form molecules and chemical substances, out of which the whole universe of things is composed. So electricity seems to be the only thing in the material world. We know that heat and light are electrical in their origin. Many think that gravitation itself is an electrical phenomenon. In speaking of the action of X-rays on bacterial troubles, we seem to see an indication that life is an electrical force. Should that be true, what is there in the universe but electricity? And what seems to be electricity? Simply energy. What becomes of our world of matter? It disappears in a universe of force, energy.

What a wonderful conclusion to reach! How passing mysterious are the ways of the Infinite, First Cause in whose image and likeness we are created. Let us bow our heads in reverence as we consider the mystery of electricity. Let us raise our eyes in adoration to the Father of All whose children we are.

QUESTIONS OF ELECTRICITY.

Who was Franklin? Describe his experiment.

What did Edison invent? Bell? Tesla?

Do you use electricity for lighting your home? Explain about the light. Who invented the filament? Why does the bulb need to be a vacuum? When you turn the switch do you turn anything on? How is the current produced? What does it consist of?

Do we really generate electricity? Electricity is said to be generated by waterpower, also by burning coal—any difference between the two productions?

Do you think we will ever be able to transform the energy now going to waste in the geysers of Yellowstone Park?

Explain the principal of a dynamo. Electricity is used to run an automobile, where do you get it? What is it to charge a battery?

What electrical sign seemed the most impressive you ever saw?

Explain an arc light.

You can see running water, is there any way you can see electricity?

What is Tungsten?

Mention an instance of great saving effected by Cottrell's electrical precipitator?

What is Potash used for?

Mention some of the economies effected by the use of central power houses in a coal field.

What is white coal?

If we could utilize all our waterpower how much coal would it save yearly?

What is voltage?

Explain about stepping up and stepping down an electrical current.

Describe one instance of utilizing the current of the Mississippi River.

Give instances of the use of electricity to haul trains.

Explain electric welding. How did it help "win the World War"?

Explain how Niagara is set to work electrically.

Mention a process by which electricity is made serviceable in country homes.

Explain multiplex telegraphy.

How many separate messages can now be sent over a single pair of wires?

Who invented the first telephone?

Explain about telegraphing pictures.

Who sent the first wireless telegraph message?

Give some instances of etheric waves.

What is the name of the waves used in wireless telegraphy?

Who first used them in telegraphy?

Who invented a process of underground telegraphy?

Are elevated masts necessary in wireless telegraphy?

Can you see any obstacle to sending electrical impulses to Mars?

What was the difficulty in wireless telephony?

Explain the degree of success attained in wireless telephony.

Give instances of wireless transmission of power.

What is meant by talking along a beam of light?

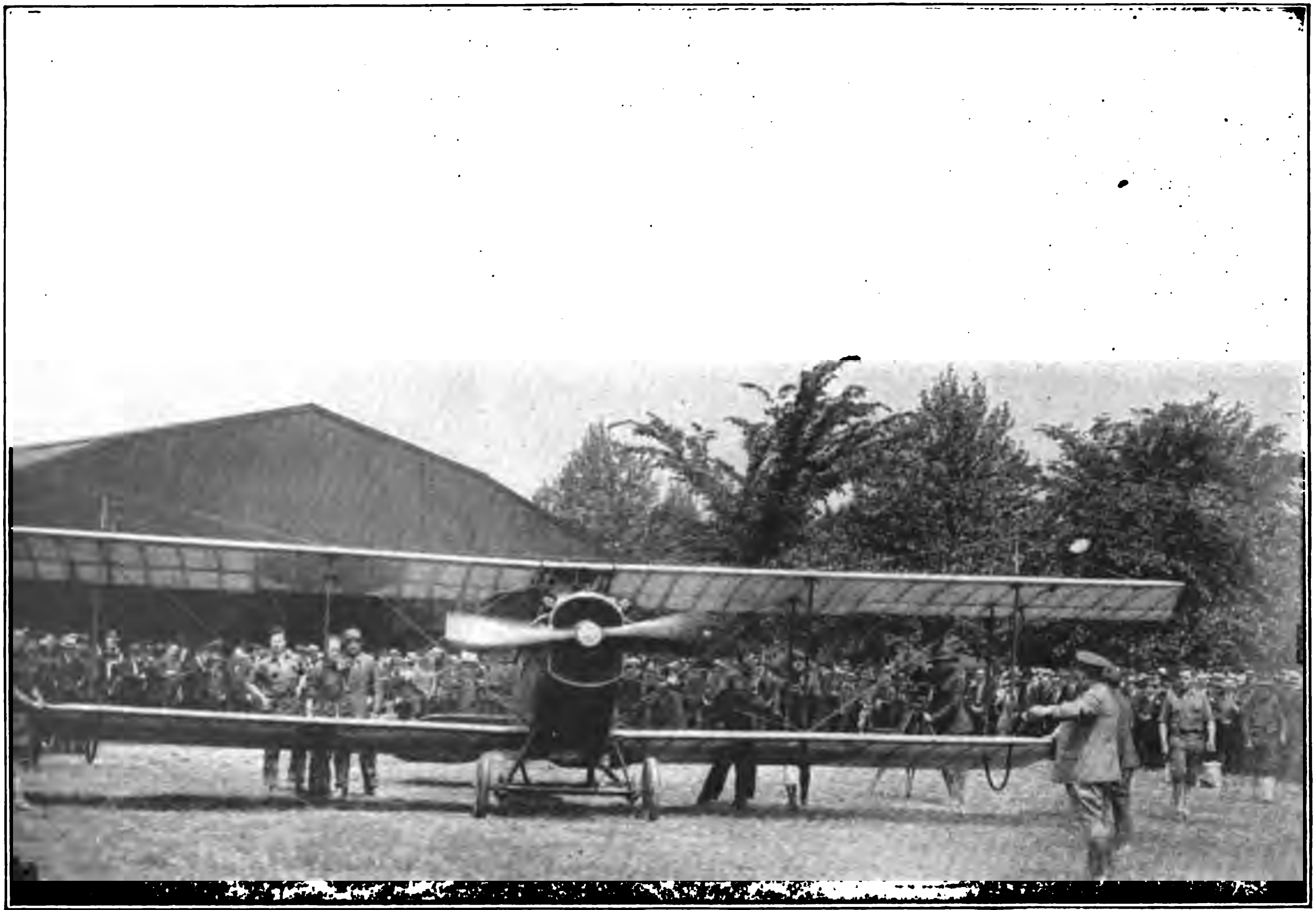
What are X-rays? How are they used? In what ways are they valuable?

Tell what you can about negative electricity.

Tell what you can about electrons—their size as compared with an atom.

What statement can you make about positive electricity?

What one thing remains in the universe?



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CARRYING UNCLE SAM'S MAIL.

The start of the first mail carrying plane from Washington. Massed between the machine and the hangar, and all around the field were hundreds of government officials all anxious to witness this epoch making flight.

THE WONDERS OF THE FLYING AGE

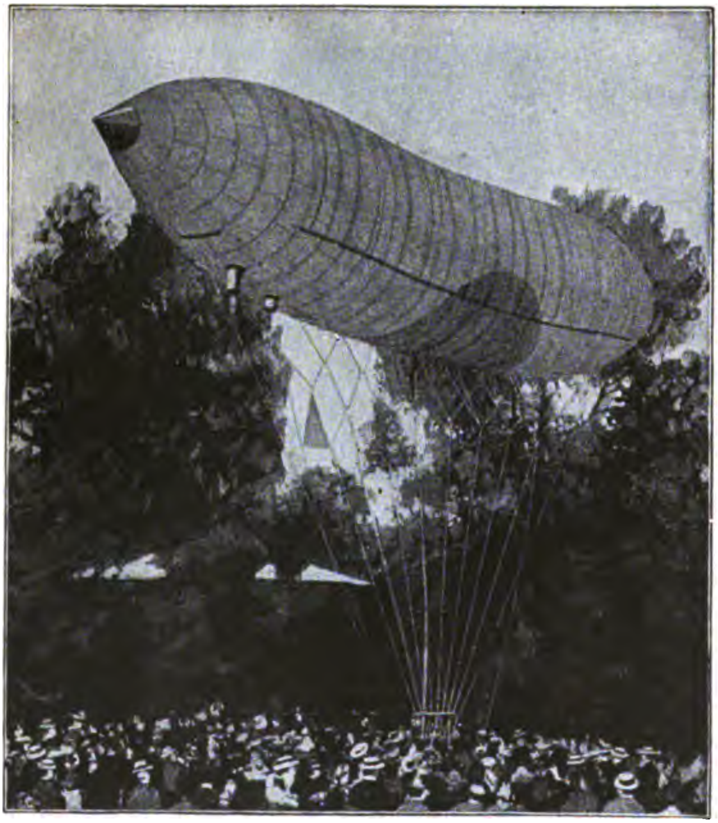
In the future we will look back to the first quarter of the twentieth century, as an era of great progress in scientific knowledge and practical application of the same; and among the achievements of that period, none will rank higher than the wonderful development of aircraft by which we are able to outdo the fable of the Flying Carpet that transported its possessor any distance through the air.

We are living in such a wonderful age that we fail to notice that is implied in the expression, "The Flying Age." When this century opened a few far-seeing workers felt that the problem of flight might soon be solved. At the outbreak of the European War, fourteen years later, the dirigible balloon was a pronounced success, but flying machines were just entering on the stage of practical development. Four years later, still, the airplane had demonstrated its great efficiency as a military machine, its possibilities for purposes of place were recognized, and an age of practical application was at hand. In less than twenty years an advance had been made corresponding to that of as many centuries in ocean navigation. It is the most amazing story of human advance ever recorded. We do not yet realize what it means for the good of man.

This volume would be incomplete if we did not make a study of this achievement and note the possibilities awaiting development. Since the balloon is older than the flying machine, we will first consider the dirigible balloon, and note its rapid development, and also note the immense future possibilities that a brilliant chemical discovery now renders possible. The air ship is entering on a new possibly more wonderful stage of development than that which has gone before.

SANTOS DUMONT AND HIS AIR SHIP.

In 1901, M. Santos Dumont, a Brazilian inventor, made a successful air ship. An air ship is a modified balloon. The lifting power is gas confined in a more or less cigar-shaped, fabric-covered receptacle. The propelling and guiding power is furnished by a propeller attached to a cradle suspended below the balloon part. Dumont made the first practical use of an internal combustion engine for aircraft purposes. It might be of interest to remark that flying would be yet unheard of had it not been for this invention, which affords a great development of power with very little weight, a condition absolutely essential in flying craft. An examination of his air ship and comparision with a Zeppelin, shows that it was a crude affair. Notice the gondola is some distance below. This was necessary to guard against the danger of fire since hydrogen with which the balloon is filled is extremely inflammable. With this machine, he was able to start from and return to St. Cloud (in Paris), circling the Eiffel Tower on his way. Notice in what the improvement over the balloon of older days consisted. He had combined with the lifting power of the balloon means of propelling and controlling its flight. The balloon is the raft stage of ocean navigation, at the mercy of wind and tide; the Dumont air ship is as primitive steam navigation, the crude beginning of a great innovation.



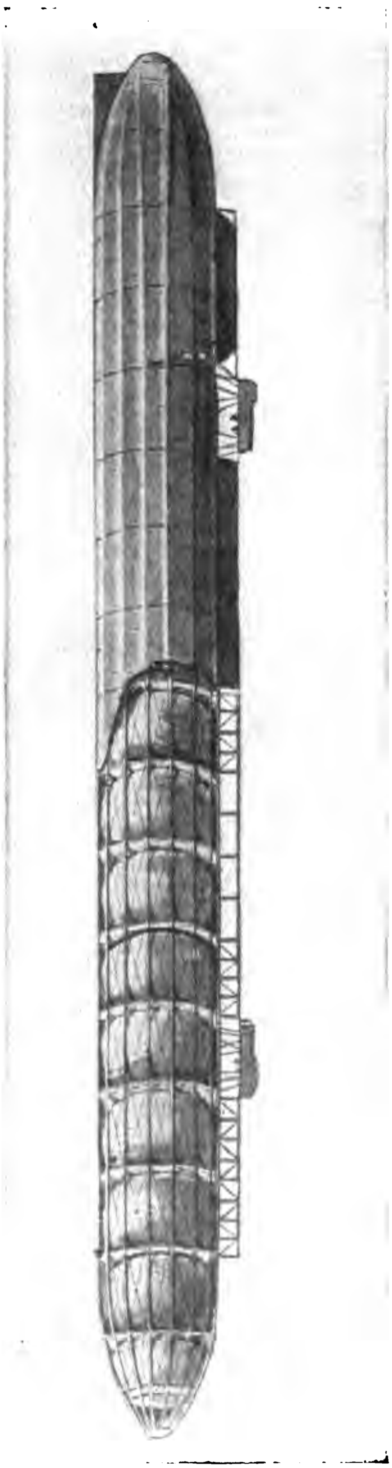
DUMONT'S FIRST AIR SHIP.

THE RIGID FRAMED ZEPPELIN.

As showing how many minds are working along the same line of thought whenever any great step is taken in human advance, we refer to the invention of the Zeppelin. Count Ferdinand von Zeppelin invented the rigid framed dirigible balloon that has since borne his name. They are rigid because the frame work is of aluminum, divided into a number of strongly braced sections in each of which is a separate balloon, the total arrangement being like a row of huge lozenges. They are dirigible, because while lifted and supported in the air by hydrogen gas, their movement is directed and propelled by means of engine-driven propellers attached to the gondolas, or cabs, underneath. These cabs, instead of being suspended by swaying lines of wire, are attached to the rigid frame work. Fire is guarded against by placing the engine in an enclosed gondola, and screening off the exhaust collectors. The Zeppelin, as modified by recent improvements, seem to mark the end of the balloon line of evolution in the art of flying. The ocean liner stage of evolution in aerial navigation seems to be reached. Before considering air machines we must see what stage of evolutions has been reached in Zeppelins and what advance we may look for in the future.

FOR PURPOSE OF PEACE.

By a study of this illustration we can see the stage of development reached in days of peace. Notice the row of balloonettes (the separate balloons); a gas tight covering is placed over the entire frame work. The air enclosed between this covering and the balloonettes protects them from rapid changes in temperature. In Germany, before the war, a regular transport service had been instituted between distant cities for passengers and freight. Tourist tickets, entitling the holders to passage on regular trips were on sale in all the principal cities of the world, and the service was very satisfactory. From the long overhead cylinder, two cabs were attached by aluminium rods. They were connected by speaking tubes. In each cab was a powerful engine; the cabs furnished quarters for the crew. They were connected by a long canvas-covered saloon for the convenience of the passengers. It was as comfortably and as luxuriously furnished as the cabins of many yachts. Celluloid windows were placed on the sides and bottom by means of which the constantly shifting panorama of landscape could be studied. Celluloid doors at the end protect against cold. At night it was electrically lighted, and heated by means of electricity. On either side were upholstered seats and collapsible tables. Meals were furnished en route. Be-


THE CONSTRUCTION OF A ZEPPELIN.

tween watches the crew slept in hammocks in their cabs as on a ship.

DEVELOPMENT FOR WAR PURPOSES.

When the war opened, Germany possessed a fleet of about twenty of these giant air ships. Some were 710 feet in length, supported by two million cubic feet of hydrogen gas, driven by six engines, totaling 1,500 horsepower, capable of carrying a crew of forty-eight men and a load of four tons. As modified for war purposes, the body was sharply torpedo shaped, machine guns were mounted on the upper surface, fore and aft. The gangway for the crew, sleeping quarters, and load of freight, whatever its nature, was carried inside the outer covering. There were three gondolas. In the forward one was the wireless outfit. The cabs were as small as possible and in each was a maze of machinery. In the captain's cab there were all the navigating instruments,—charts, compasses, sextants, and a variety of instruments peculiar to Zeppelins. As an instrument of war, the Zeppelin was a distinct failure, though damaging raids were made on both London and Paris. Their comparative failure was largely owing to the inflammable nature of the gas. One bullet from a machine gun of an airplane might destroy one of these monsters. But their usefulness was shown by such a fact as this: late in the war a super-Zeppelin with four tons of ammunition and medicine was dispatched

A ZEPPELIN JUST STARTING ON A CRUISE.

from Berlin to South Africa. It was halted over Kartoum by a wireless and ordered to return. Such a ship is perfectly able to cross the Atlantic.

THE AIR SHIP GIVEN NEW LIFE.

When the war ended and the veil of secrecy lifted, there was disclosed a military secret that promises a wonderful future for air ship development. It is the quantity production of helium gas. No more surprising development was ever accomplished. In previous years helium gas cost about $1,700 a cubic foot; as a result of intense research work and practical application of the same, a cubic foot of helium gas is now worth about ten cents, certainly a wonderful reduction in price, and a plant was being built capable of producing 50,000 cubic feet a day—an incredible amount (it would have been considered) in former years. How little we know about Nature's hidden stores of wealth. There may be many more such surprises in store for us.

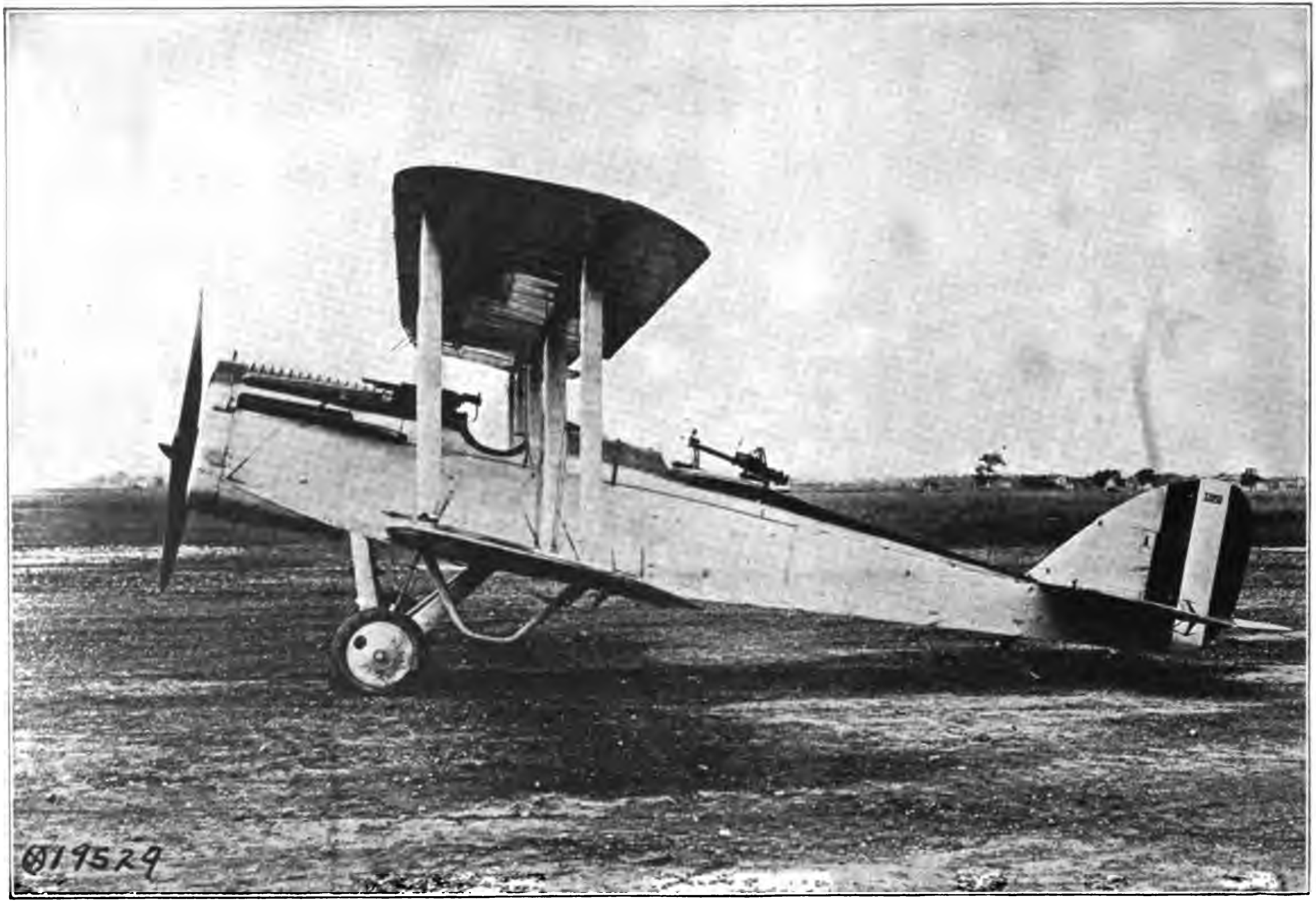
IMPORTANCE OF THIS DISCOVERY.

Helium is next to hydrogen, the lightest gas, its lifting power is only eight per cent less than hydrogen. Its great advantage is that it is absolutely non-inflammable. It also refuses to absorb and so form an explosive mixture with air as hydrogen will. Here, then, is disclosed most alluring possibilities for air ship development. In a steamer the propeller is the only part in the water. In the air ship of the future the engine, crew, and supplies of all kinds will be carried in the enclosed hull with the lifting balloonettes of helium safely framed above. The frame work of the ship will be given a streamlined shape (the body of a fish.) As a result of this great discovery, experts, after careful investigation, declare that the air ship is superior to the airplane in the matter of security of travel, reliability of power, efficiency of service, comfort of travel, and expense; inferior only in the matter of speed. It is believed that giant ships of this kind will make trans-Atlantic voyages commonplace, carrying passengers and large quantities of freight. The safety and comfort of the passengers will be as great as in the slower moving ocean liner that the air ship will pass and rapidly leave in the race.

It is said that England is about to build a veritable Titanic of the skies for trans-Atlantic service. Its engines are to total 3,500 horsepower, and it will have a freight carrying capacity of about 70 tons. Passengers are to travel with the comforts of a liner. Compartments are to be in a saloon fitted at the top of the air ship, provided with tables and chairs in the style of a Pullman car. Part of the saloon will be fitted up as a smoking room. An open deck is to be provided for a promenade. The sleeping quarters will be small cabins fitted with berths. The time of passage is to be from forty to fifty hours.

MANY STARTLING DEVELOPMENTS AT HAND.

Should these plans mature they will mark the end of a most interesting development. It is well to mentally review the steps of the same from the hot air balloon of 1783, through the Zeppelin stage of construction to the mammoth air ship now made possible by the use of helium gas. It should be added, however, that in spite of these brilliant possibilities, aerial engineers and inventors seem to think that the future lies with the air machine. They think that the real flying age just before us will be marked by



Squier.

A MODERN AIRPLANE.

This is a DeHaviland 4, one of the latest planes developed for war purposes. Notice, it was armed with a machine gun. It was a Biplane, though the lower plane is not clearly shown. The entire arrangement will be modified for peace purposes.

a wonderful, and to present thought, an almost incredible development of air machines.

A MECHANICAL BIRD.

An air machine differs from an air ship in being heavier than air, yet supported when in rapid motion by the uplifting power of the air. For ages, long before human life began, nature constructed splendid models of flying machines in birds. When the Wright brothers flew their first machine it did not look much like a bird. But with every step in advance since that memorable day, December 26, 1903, we have more and more approached the model that nature spreads before us. We have, in effect, made a mechanical bird. Whoever watches an airplane in flight cannot help but note the resemblance to a bird, say a hawk, sailing in the air. The simple fact is the nearer we approach the model the greater success we attain.

Wilbur Wright.

Orville Wright.

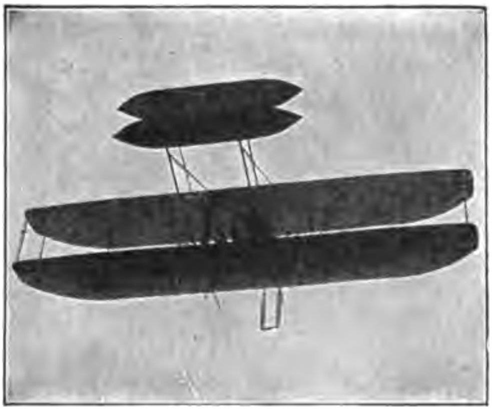
The Wright Brothers made the first successful heavier than air machine This result was achieved only after long and faithful experiments. One after another details were added. Success came to them in 1903.

STUDY OF AN AIRPLANE.

If we make a study of this illustration, which is that of a recent machine we will see how true this statement is. The long fish-shaped body is called the fuselage, a body so shaped is said to be stream lined, it presents the least resistance to forward motion. The bodies of all birds in flight assume such shapes. The planes are the outspread wings. As with birds, the body (fuselage) must extend some distance behind the wings so that the rudder can work in steering. The rudders on the plane are the tail feathers of the bird. The next time you notice a pigeon flying observe the outspread tail feathers. In Wright's first machine this effect was obtained by the steering planes in front; afterwards there was employed simply a long open framework extending behind; we now cover in the entire body. Just as nature covers in her bird bodies.

THE WINGS OF OUR ARTIFICIAL BIRD.

In one respect we have not yet succeeded in making a close copy of nature; or rather, let us say, we have to employ two devices to perform the work that nature accomplishes with only one. Nature employes the wings of some of her flyers for both flapping and soaring purposes. In our mechanical bird the planes are the outstreached wings used in sailing, the revolving propellers are the flapping wings. Nature folds the wings of her flyers neatly about the body when not in use. We have not yet succeeded in any such arrangement, though constant improvements are being perfected on the wings. Looking at the edge of the plane one notices it is curved, that curve is the camber of the plane. In this, also, we faithfully follow Nature, for she curves both surfaces of the wings of all her feathered flyers. The reason for so doing is that when in forward flight the curved surface produces a partial vacuum above the wing and the uplifting power of the air on the lower surface is greatly increased. Mother Nature evidently considered and solved all questions of flight, long before we did. Our best hope of success is to follow her models.



THE FIRST SUCCESSFUL MACHINE.

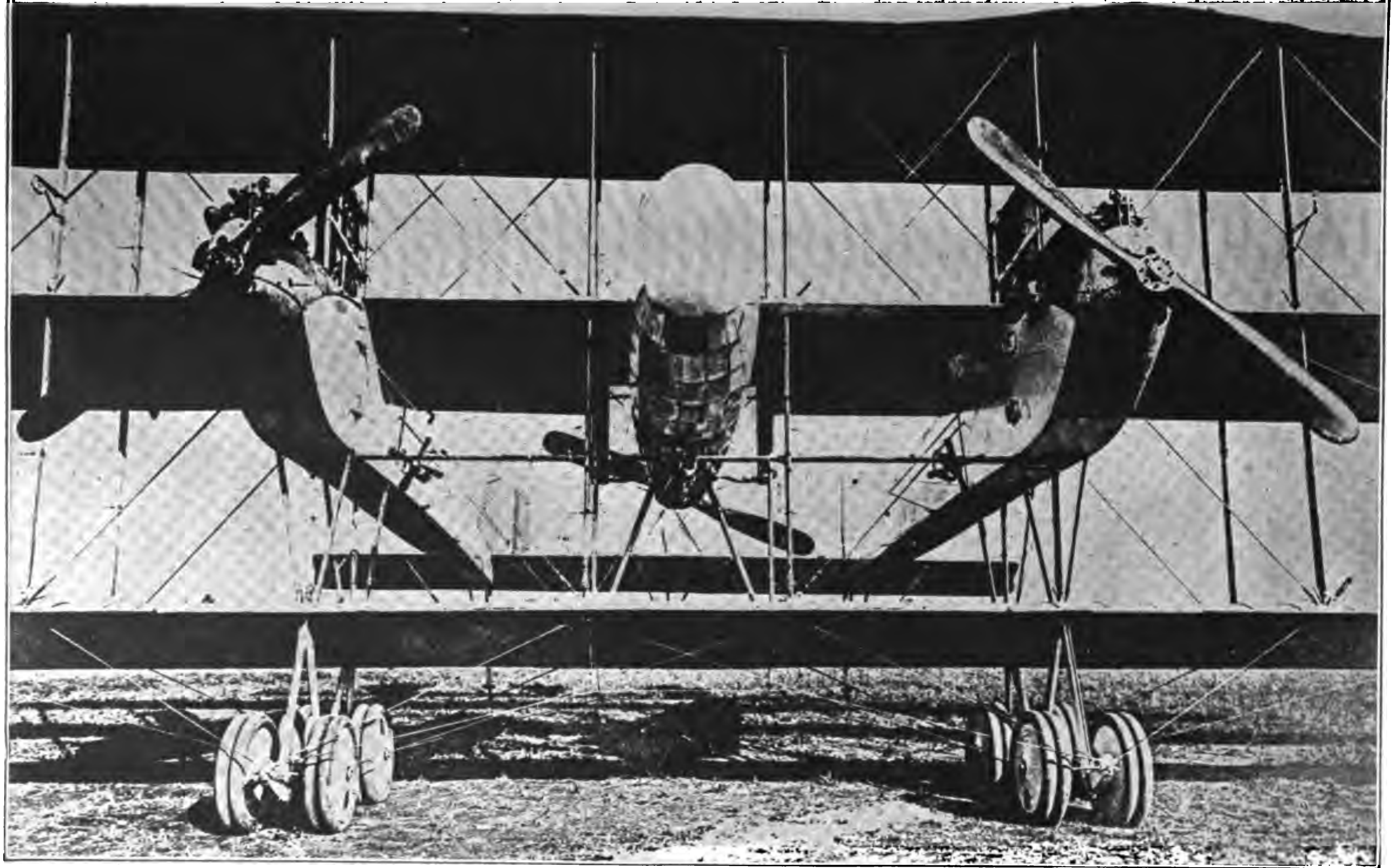
This, the first successful machine should be compared with the De Haviland 4. Notice that while eyery detail in construction has been modified the essential principals remain the same. The planes or wings have been the least changed. The fusilage has been evolved, the landing gear changed, the position of the rudder changed. The first successful flight of this machine was December 17, 1903. We have experienced a marvelous development since that time.

COPYING NATURE.

This is so true and now so well known, that during the World War, army officers visited well known zoological gardens, as at Cincinnati, and made careful study of the large soaring birds there confined. They made most accurate measurements of the wings;—their spread and curve, and the location, length, and use of all muscles and tendons of the wings under different conditions of flight; and as a matter of fact American airplanes shipped to France during the later months of the war were braced and their wings curved according to such studies. The natural result followed—these planes were among the best produced. Mother Nature must be surprised and gratified at the success we have made in following her model. But we have outdone her, for we have perfected a mechanical bird vastly stronger than any of her flyers; one that can fly faster, longer, and higher than any she has developed; and can perform more spectacular turns in the air than any tumbler pigeon ever attempted. Ages ago, Nature set great dragons flying in the air. Leaving the graceful bird form behind, we are now going to outdo Nature's work of old in the flying monsters we shall utilize for purposes of peace.

VARIETIES OF AIRPLANES.

Just as Nature developed different types of birds,—such as eagles and vultures, geese and ducks,—so we have developed different types of airplanes; but since these different types were developed to serve different purposes in war, we need only describe them in a few general remarks since they will now be modified for purposes of peace. They differed in ability to rise quickly to a great height, in swiftness of flight, and in carry-



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AN ITALIAN TRI-PLANE.

For the first time in history, flying machines have been used for purposes of war, and have become almost as necessary as cruisers on the sea or artillery on land. Army movements are directed from the air, and battles are waged thousands of feet above the surface of the earth. Several distinct types of machines are made, each for a different purpose. This is a three plane battle machine. It can make about ninety miles per hour, which is slow for aeroplanes; but it is capable of carrying three tons besides its crew and nine machine guns. It has three engines which can develop 700 horse power. It is a real dreadnaught of the air.

ing power. In accordance with their grading in these respects they were known in general terms as scouting planes; fighters, or battle planes; and boomers. They are also classified according to the number of planes with which they are fitted,—as monoplanes, bi-planes, and tri-planes. The planes used by the navy are known as seaplanes, the very latest ones are flying boats. The essential difference between the airplanes and seaplanes is in the landing devices. In our illustration the landing device consists of rubber-tired wheels. In the seaplane the wheels are replaced by pontoons since they are to land on water. With the development of the high-powered liberty motor came the development of the flying boat. The fuselage is replaced by a veritable boat needing of course, no wheels for landing purposes. What we must investigate is the application of the highly developed airplanes heretofore used in war to the needs of peace.

RAPID DEVELOPMENTS.

The airplane developed faster and in a shorter space of time, than any other mechanical device, not excepting automobiles that man ever invented. The Wright brothers made their first successful trip in 1903, with a sixteen horsepower engine. They attained a speed of about 37 miles an hour. In judging future possibilities, we must note some of the records now made. We must understand, however, that all records are temporary. No doubt the most advanced one today will soon be outdone. One hundred miles an hour was the average speed of big machines in the closing months of the war; one hundred and fifty miles an hour was nothing unreasonable for light scouting planes. Airplanes engineers estimate that if you desire speed only, 250 miles an hour is not out of reach. One war record was that of a machine carrying five men flew across country from London to Constantinople, dropped bombs on a cruiser anchored there, then flew back to Salonica, covering a total distance of more than 2,000 miles and remaining in the air thirty-one hours. The record for height is held by an English machine that ascended to an altitude of 30,200 feet (nearly six miles), a greater height than the highest peak of the Himalaya Mountains. A machine carried a sight-seeing group of forty, took an hour's leisurely spin over London, flying at the height of 6,000 feet. One of the big Italian Caproni planes carried seventy-eight people in a trial flight. Others capable of carrying several hundred people are in process of construction.

WHAT WE MAY EXPECT.

To those considering the first steamer that astonished the world, representing in itself a wonderful accomplishment, a modern liner would have seemed a Jule Verne's dream. The first railroad train, making before unheard of speed across the country, compares with a modern limited about as these present airplanes, and their records will compare with the airplanes of the near future. Lest this be thought too strong a statement let us add that several passenger and freight airplanes are designed that will possess engines totaling 5,000 horsepower, while it is announced that the Caproni plant in Italy is to build a mammoth cruiser capable of carrying a large number of passengers, a large crew, tons of merchandise and supplies across the Atlantic; and the passengers will have comfortable cabins, ample room in which to

MAJOR SCOTT, COMMANDER OF R34 (ON THE LEFT) AND LT.-COM. LANDSDOWNE, AMERICAN GUEST (ON THE RIGHT)

THE FIRST DIRIGIBLE TO CROSS THE ATLANTIC

The first aircraft to cross the Atlantic was the United States NC-4 that left Trepassey, New Foundland, May 16. But this seaplane stopped at Azores, then at Lisbon, not reaching England until May 21. The first direct nonstop flight was June 14 from St. Johns, New Foundland, to Clifden, Ireland. The dirigible R34 made the first westward passage from Scotland to Long Island, starting July 2, 1919. It made the first round trip passage as it left on its return voyage July 10, 1919.

move about and view the sea beneath, but they must make good use of their time, for not more than a day and a night will be required for the trip.

TRANS-ATLANTIC SERVICE.

After trans-Atlantic flight has been perfected the multiplication of aircraft will undoubtedly be rapid far more so than was the early multiplication of steamships a hundred years ago. At the beginning, the steamship was a very crude and unsatisfactory affair. The Savannah, the first to cross the Atlantic, would look like a tender alongside a modern ocean-going vessel, and it requires twenty-two days for her initial voyage. Aircraft, of all known types, are already highly developed. They have performed wonderful feats in the air, they have been engaged in war, they have made voyages by night over land and sea, they are products of the most advanced technical schools, they are manned by highly trained navigators. Fully twenty years were crowded into the experience concerning them in the four years of the great war. Successes and failures count alike as assets for their constructors. From the moment that the Wrights were able to sustain a heavier-than-air machine above the earth, every step from flights over sandhills to flights over prairies, over rivers, over mountain tops, over the British Channel, over continents, has been in the natural line of development.

The beginning of a new era in transportation is at hand. Continents and countries are being brought into closer relations by aircraft than they were by the submarine cable or by radio-electricity. All port laws and customs rules must be revised to meet new conditions. Any adequate survey of the future of civilization must involve an inquiry into the future of transport, and it may well be that transport by air will rival and even surpass transport by land and water. Such a consummation is probably closer than the wise men of the world suspect. Arrangements are now making for development of aircraft that are bewildering in spite of recent achievements. Seaplanes are being built capable of carrying 20,000 pounds of freight, and we are assured that entirely new types of machines will soon appear, possessing a speed hitherto unheard of and other capacities not now deemed possible. Not only has invention and progress been unsurpassed in recent years, but we are soon to see more wonderful developments. The real flying age evidently is just beginning.

FOUNDATION ON WHICH TO BUILD.

Approximately ten billion dollars were invested by European and American countries in laying a foundation on which to build for future needs. Our country alone invested $1,500,000,000 in such foundation work. This has been expended in constructing aircraft factories, engines, airplanes and hangars; in obtaining raw material and landing fields; in training aviators and mechanics; and in making aeronautic machinery, equipment and accessories. That investment was not wasted, it will be readjusted to the needs of peace; and the aeronautic world is making such adjustments and laying necessary plans for a brilliant future. We will no longer need scouting, fighting and booming planes—except a limited number reserved for possible military needs—but we will need racers for purposes of sport,—just as we now have race horses, motor boats, yachts, and racing automobiles; we will need comfortable family fly-abouts,—as our citizens now need touring and pleasure automobiles;

finally we will need aerial bus and truck lines, mail and express carrying planes, international and trans-oceanic, commerce and passenger carriers of the skies. We are assured by experts that the day of larger airplanes is at hand because, commercially, they are more economical than the small planes.

WHAT THE BUSINESS WORLD IS DOING.

British companies are regularly operating airplanes between London and Paris, carrying people each way on schedule time, making the round trip daily, allowing four hours in either city for business purposes. An aerial express line connects London, Manchester and Liverpool, making round trips daily. The committee appointed by Great Britain to study aeronautic questions unanimously concluded that it would be but a few years before air passenger lines would be running from London to all parts of the world; and that it would soon become common place for a business man to fly four or five hundred miles, transact some necessary business, and return the same day. Just a day's outing, you might say. Canada is about establishing a passenger line from Montreal to Toronto, and another to Halifax. It is freely predicted that before long Canadians will be flying to New York in the morning to transact business, returning the same day; and that New Yorkers will be flying to London and Paris for week-end visits.

In the British airplane service about to be installed from London to all important cities of Europe, the planes will have wireless combined telegraph and telephone instruments, and as each plane will be numbered or have a distinctive name, it will be possible to send from any part of the world, or from any ship in the sea, messages direct to any wished for airplane. What a wonderful combination of results!

AMERICA NOT TO BE OUTDONE.

In this country business men are about to establish a line of flying boats between New York and Boston, capable of carrying fifty people each way. The distance, 200 miles, can be easily covered in two hours. The schedule as arranged allows a business man in Boston, having a committee meeting in New York, to take a restful ride in the morning,—enjoying the beautiful panorama of mountains and valleys, busy cities and prosperous towns, land and sea,—attend to his business and return home in abundant time to prepare for dinner.

Air lines connecting all of the states in the Union have been mapped out and officially approved. One from New York City goes directly west to San Francisco, touching all of the chief intermediate cities; one from Washington to San Antonio, thence west to San Diego; one from Boston through the Northern States to Seattle; one from Bangor to Key West; one from Key West to the Rio Grande, touching all gulf ports; and one from San Diego to Puget Sound.

With but one exception—Russia—every great country in Europe is making feverish efforts to realize the benefits of this new method of transportation. It is realized that it is to be a matter of very short time when every important city in Europe will be located on air lines, linked together with the great capitols of Europe, and with the chief cities of America.

THE UNIVERSAL LAW OF PROGRESS.

We may set it down as an axiom that whatever method of travel reduces time in passing from place to place, no matter what the danger, inconvenience, or expense may be at the beginning, it will finally be adopted by man, dangers will be eliminated, expense reduced, and inconveniences changed into means of enjoyment. It has been so through all ages of history, it will hold good in aerial travel. Such travel is now, for peace purposes, as safe as any other method, it transports one over any considerable distance, in a fraction of time demanded by any other method, and it bids fair to become one of the most pleasing methods known.

CARRYING UNCLE SAM'S MAIL.

The great usefulness of airplanes for the transport of mail is already manifest. The route between New York and Washington has proved a great success. The planes start regularly on schedule time, rain or shine, and have reduced the time to two hours. The route between New York and Chicago has been tried out. The preliminary efforts have shown that it is possible to mail letters in New York in the morning and have them delivered by city carriers in Chicago in the afternoon of the same day. It is proposed to establish a few trunk lines, as from Boston to New York, Washington to New Orleans and from New York to Chicago, Cleveland and San Francisco. In accordance with an act of Congress passed in 1918 the route from Chicago to San Francisco was surveyed by means of experimental trips. Hangars were ordered, landing fields obtained, and the route ordered established. It is the intention, ultimately, to establish cross lines until the entire country shall be served by aerial mail. The advantages to be achieved are great; the time will be less than half that at present; the expense, finally, no greater. Plans for fifty-two new air-postal routes were worked out in 1918.

MAIL TO FOREIGN LANDS.

But this is only half the story. Plans are laid to extend the service from Key West to Havana, thence to the West Indies and Panama, thence to South American countries, to the mystification, no doubt, of the condors on Chimborazo heights blinking at the huge bird defiantly invading their mountain home. We must try to realize what is implied in being able to send letters from New York to Valparaiso, Rio de Janeiro or Buenos Aires in a few days, instead of a few weeks or months. But we must enlarge our view until it includes the whole world. Regular landing places have been established for a line from London via Paris, Rome and Constantinople to Bagdad and Cairo. Peking and Tokio will next be added. New York to London will no doubt soon be an established fact. Thus, the whole world will be linked up. All these results are in sight, so to speak. They do not wait upon some fortunate discovery yet to be made. The facilities to accomplish them are at hand.

INEVITABLE ADVANCE IN CIVILIZATION.

Civilization has been advanced by every improvement in transportation facilities made by man. A great advance was made when the Phoenicians established trade routes threading the Mediterranean. Another great step was taken when ocean navigation became possible, then came the use of steam on water and land, with which the present stage of culture began. What marks the present in particular is the great development of railroad transportation. A vast amount of developing work remains to be accomplished before the mighty stimulus of quickened circulations due to aerial transport will be felt. But just as sure as steam surpassed winds and sails; as sure as railroads surpassed the stage coach; just so sure will the flying age now opening make possible transportation methods surpassing those of the present; and that means advance in every department of culture. All history confirms this conclusion.

SEA POWER.

We have heard much of sea power lately, meaning by that term the ability to command the sea by a strong navy and huge merchant marine. Owing to the possession of both of these factors, England is known as the mistress of the seas, a position she has occupied since the battle of Trafalgar. But unless we totally misread the signs of the times, in the new age, it is to be air power that will dominate the situation in war and in peace. In the infancy of the art we have seen the "winged cavalry of the skies" playing a great part in the war. That arm of service was rapidly becoming the decisive factor. Many clear thinkers believe it will be such in future wars, should the world be longer cursed with war. There is no doubt that aircraft will play a great part in future commerce. We may therefore set it down as undeniable that we are to witness great efforts on the part of every advanced nation to build up a strong aerial navy and commercial fleet. Every advanced nation in the world is laying plans to this end. Our own country should have no difficulty in taking a commanding part in such activity. We have demonstrated our ability to produce aircraft in quantity; our engineers built one of the most capable all-around engines—the Liberty motor—for aircraft purposes.

CONCLUSION.

Aerial navigation is an accomplished fact, but we are yet in the infancy of such activity, for purposes of peace. The tremendous energy displayed in development for war purposes will accomplish equally as great results in building commerce carrying fleets. Prophecy is always accompanied with danger that realization will fall behind our hopeful assertions, but we feel safe in claiming that a stage of development in aerial navigation equal to, if not surpassing that through which ocean navigation passed from the time of the caravels of Columbus to the present day of palatial liners awaits aerial activity. It may well be that the present flying machines will constitute the motor boats and pleasure yachts of the future, while through the air will speed massive freighters and stately liners serving the needs and the pleasure of a more brilliant civilization.

QUESTIONS ON FLYING.

What is the difference between an air ship and a flying machine?

When you send up a toy balloon the 4th of July why do you heat the air?

What is the difference between an ordinary balloon and a Zeppelin?

How does a Zeppelin differ from Santos Dumont's airship?

What is the difference between helium gas and hydrogen?

Since an air machine is heavier than air, what holds it up?

Why are airplane wings slightly curved?

Since we are copying nature what mechanism in an airplane reminds you of a soaring bird?

What of the flapping wings? What of the expanded tail?

In what way will the development of airplanes for purposes of peace differ from the development for purposes of war?

Which can travel faster, an airplane or a Zeppelin?

Mention some points in which a Zeppelin is superior to an airplane for purposes of flight.

Give some points of superiority possessed by an airplane.

What is an airplane with only one pair of wings called? With two pairs? With three pairs? Why not have airplanes with, say, four planes?

What part of the airplanes is the fuselage?

The United States invented a very excellent engine for airplanes—what is it called?

Who invented the first successful air machine?

Why is trans-Atlantic flight important?

What is the difference between a flying boat and an airplane?

The automobile was for years a sort of toy, it has revolutionized life. Do you think a similar result will follow from airplane development?

Give some reasons for your conclusion.

Sea power has meant much to nations possessing it.—Will air power be equally important?

Do you think it will ever be possible to travel from New York to San Francisco in one day?

Trace the advance of civilization that accompanied increased facilities of intercommunication from caravans of early times to the present.

Will a similar advance follow from aerial navigation? What makes you think so?

Which is the more important, aerial navigation or wireless methods in electricity?

What common invention made both automobiles and airplanes possible?

Carefully reading this section, in what way do you think aerial navigation will influence social life during the next decade?

Which better characterizes the present, the age of electricity or the flying age?

STARTLING RESULTS OF MODERN SCIENCE APPLIED TO PURPOSES OF WAR

It has been shown that owing to the great advance in the practical application of electricity and the development of aircraft the texture, so to speak, of modern life is changing, and we are entering on a new age of social activity. It was inevitable that, in the event of war, similar revolutionary changes would appear. A review of activities on land, on the sea, and in the air as displayed in the World War is most instructive; affording us another angle from which to view human activities shaped by modern science, devoted to work of destruction but which served to usher in a new age with higher ideals of national life, higher planes of thought and action, in keeping with the higher knowledge of this wonderful era. This study is not to be a history of the war, but a review of its activities, to note the application of science to war, and observe how widely modern methods of warfare depart from earlier usage. The frame work of war remains as of old, the details have changed in accordance with advancing knowledge in general.

DEATH DEALING SUBMARINES.

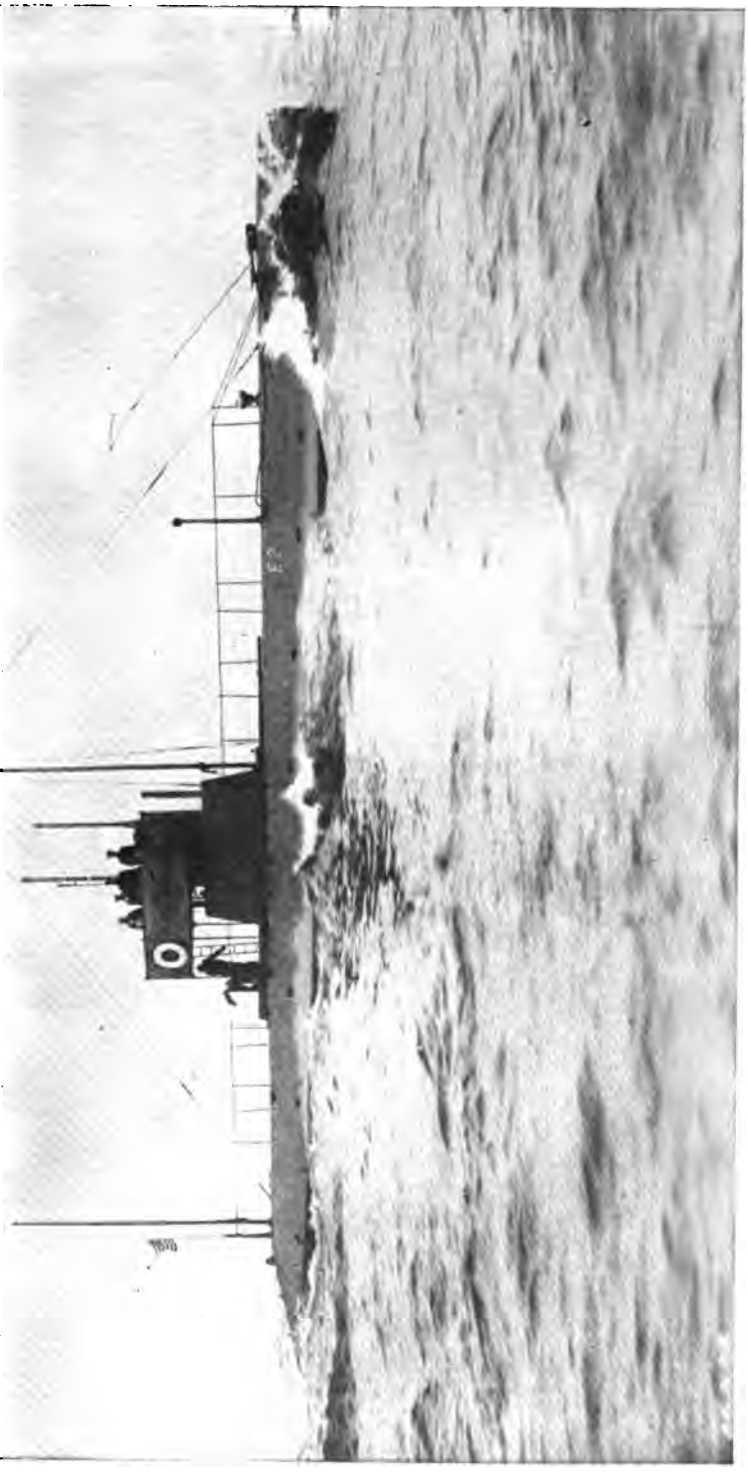
During the World War submarines were used on an extensive scale for the first time in history, and this new arm of attack called for new means of defense. The German submarines were popularly known as U-boats. While the submarine was the result of American inventive genius, it was Germany that made the most of the invention, and that nation possessed a formidable fleet of submarines with which she fully expected to be able to command the sea. She failed in that, but the submarine demonstrated its extraordinary effectiveness as a commerce destroyer by sinking nearly a third of the total ocean-going tonnage of the world.

DISTANCE OVER WHICH SUBMARINES OPERATED.

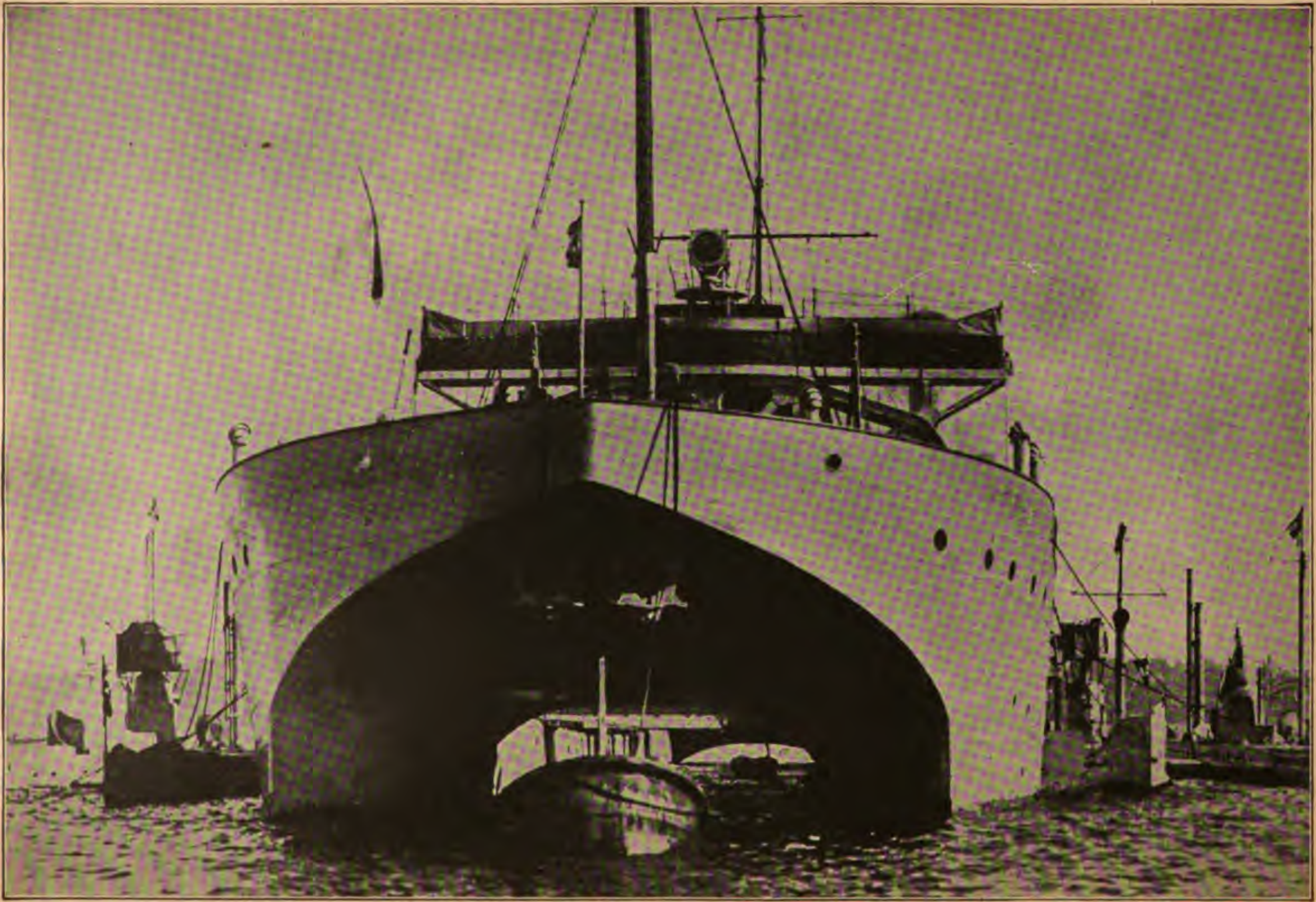
It was formerly thought that submarines would be useful only as a harbor defense boats because their sea-going power was so limited. Recent improvements greatly increased their effectiveness. They underwent a remarkable development. The first submarine had a length of 53 feet and a displacement of 73 tons. The submarines used in the war were, many of them 250 feet in length, displaced about 800 tons, had a surface speed of about 17 knots, and a submerged speed of about 12 knots per hour. They were armored, provided with torpedo tubes, had guns mounted on the deck, and were provided with wireless appliances, supplies were carried sufficient for a cruise of thousands of miles. They circled the British Island, were active off the coast of Spain, navigated the Mediterranean and crossed the Atlantic, sinking ships within sight of New York; and as all know, before we became involved in the war, a submarine freighter made two trips to our ports, thus demonstrating unexpected efficiency in a new direction.

HOW A SUBMARINE IS OPERATED.

The manner in which a submarine boat is operated is interesting, but difficult to describe in plain language. Briefly, the sub-



THE LATEST TYPE OF UNITED STATES SUBMARINE.



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A MOTHER SHIP TO SUBMARINES.

The mother ship is supplied with everything needed in the repair of submarines. It will be noticed that the submarine can be lifted entirely out of the water, so as to examine and repair the bottom or the rudders. Within, the submarine is a maze of delicate machinery and electrical appliances of all kinds, and after every trip it is necessary that they be carefully examined, tested and new parts supplied, etc.

marine has a sort of a dual existence. When the boat is awash—that is, running low on the surface—it is operated by its gasoline engine just as a motor boat is run. When it submerges it is operated by electric motors. The steering, pumping, handling, loading and firing of torpedoes is done by means of compressed air and by electricity.

THE EFFICIENT ENGINES.

The gasoline and electrical engines are marvels of compactness and efficiency. The gas engine may be used to drive propellers directly, as when cruising on the surface—or it may be disconnected and drive a dynamo, which in turn generates electricity for charging storage batteries. The boat can then submerge and the electric motor, drawing upon the power thus stored, can drive the propellers and do all necessary work.

The gas engine is useful in other ways. It is made to operate an air compressor, and compressed air represents power which can be used for a number of purposes, such as for operating machinery, driving the bilge pumps or for forcing out torpedoes. For this purpose, air compressed from two hundred and fifty to three hundred atmospheres is used, or yet again the air pressure is used for running the tail shafts which operate the propellers.

THE PURPOSES OF THE WATER TANKS.

The specific gravity of the submarine as a whole varies with the amount of water in the ballast tanks. When these tanks are empty, the weight of the boat as a whole is about three-fourths that of the water it displaces. So it can be made to float low or high by simply adjusting the water ballast in the tanks, which are located in the bow and stern of the boat. This process is called trimming the tanks. Unless this balance be correctly adjusted, the boat is liable to turn turtle when running fast; besides, at times it is necessary to let the boat, when submerged at a wished-for depth, float, which can only be done by properly trimming the boat.

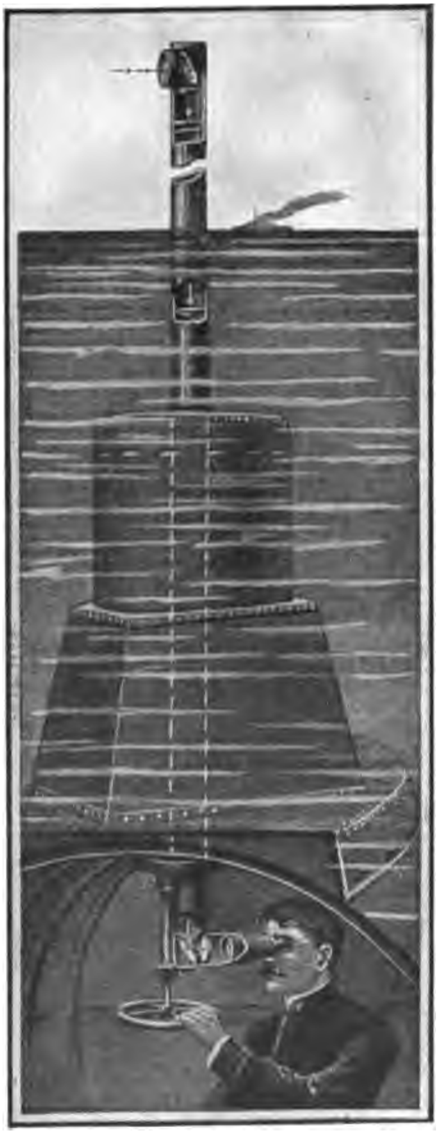
STEERING THE SUBMARINE.

The motion of the submarine when under way is controlled by two sets of rudders; one of these sets, known as the vertical rudders, directs the boat's course to port or starboard just as does the rudder of an ordinary ship. In addition, there are provided horizontal rudders, which serve to control the motion of the boat in a vertical plane, that is to say, the depth at which it runs is regulated by these rudders. For steering in the horizontal plane, instruments are provided, so that the boat may be navigated with the same degree of accuracy as boats on the surface.

THE EYE OF THE SUBMARINE.

The periscope is the eye of the submarine. It consists of a vertical tube which extends from above the surface of the water to a few feet within the submarine. Of course when running some distance below the surface the periscope is completely submerged. At the top of the tube is an object glass, at the bottom, an eye-piece. Two reflecting mirrors, one at the top, the other at the bottom of the vertical tube, cause the image to be transferred from the object glass to the eye-piece. The operator can turn the periscope so as to sweep the whole horizon, the view being as clear as though he were at the surface looking through an ordinary field-glass. Hence, when running submerged with the top of the periscope just out of the water, the navigator can see by day with perfect ease surrounding objects.

Later submarines had two periscopes, one for the helmsman, looking straight ahead, and one for the commander, giving a zonal view all around, with binocular enlargement when desired.



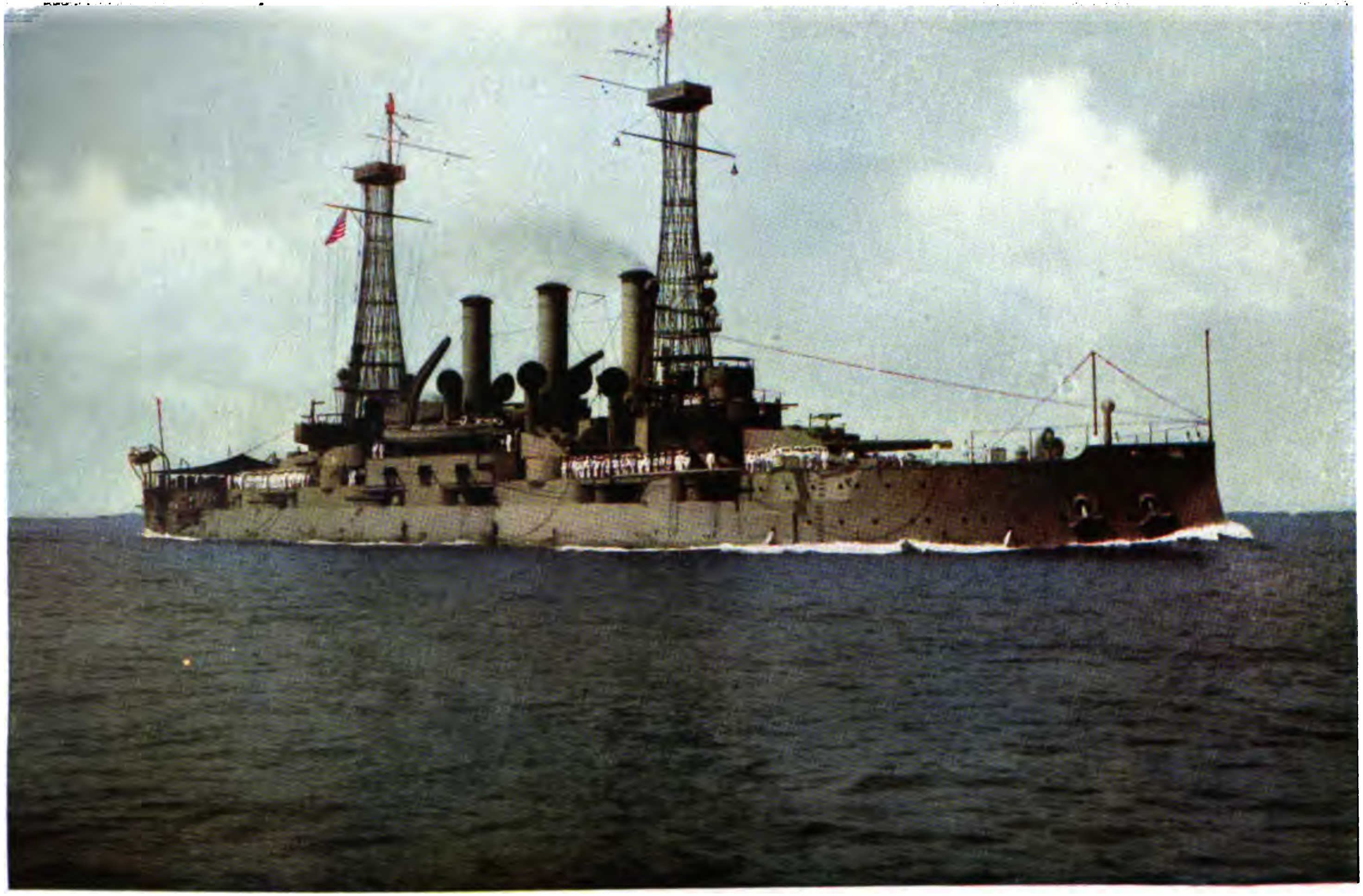
THE PERISCOPE.

DIRECTING ITS COURSE WHEN SUBMERGED.

If for any reason it should be desired to run at a still greater depth, compasses are provided by which the course may be steered with accuracy. For steering submerged, in the vertical plane, instruments are provided which in a way take the place of the compass. One of these is a large pressure gauge, which indicates the depth at which the boat is running. Another is a form of spirit level, which indicates the inclination of her axis. By the use of this, the man controlling the horizontal rudder is able to run at a perfectly even depth. Other gauges and dials indicate the vessel's speed, the amount of fuel oil carried, the stored electricity on hand for submergence runs, the reserve compressed air for breathing and for launching torpedoes, the temperature, water on hand in ballast tanks, etc. Everything responds to the touch of a handwheel, a switch, or a lever. There are no other operating motions. While in submerged condition, the boat is, of course, amply illuminated by electric lights. There are no ports or windows in the boat, and, so far as sensations are concerned, one is unable to determine whether the boat is running on the surface or is submerged.

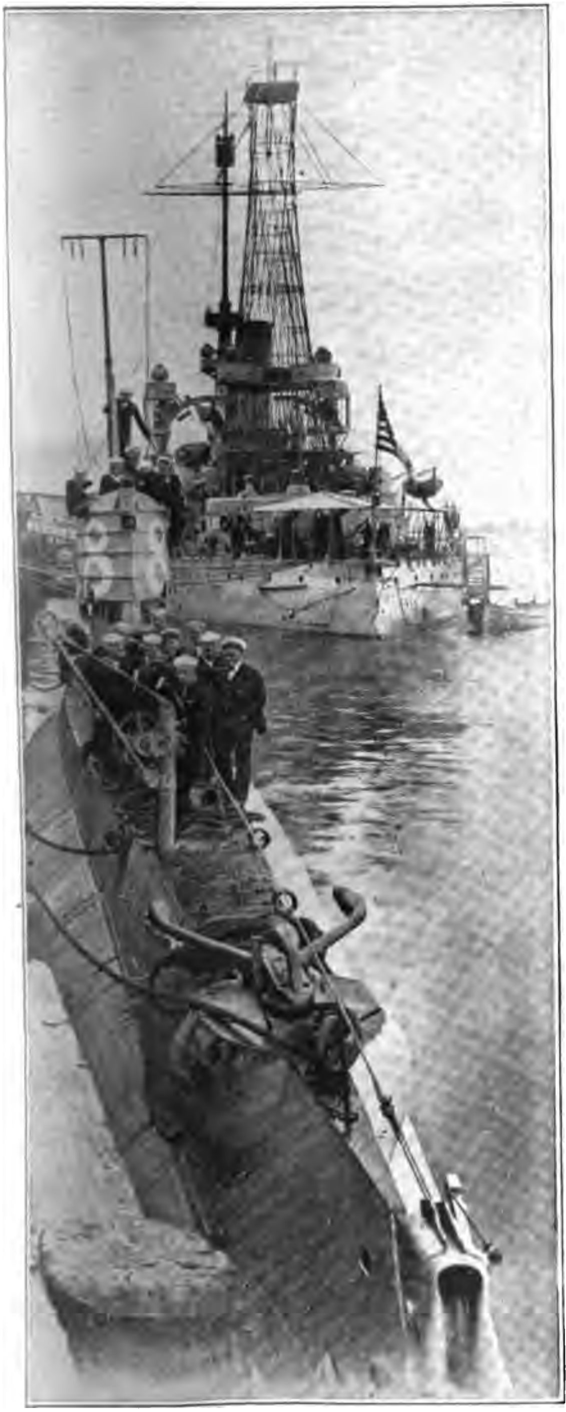
THE OLD AND THE NEW.

In this illustration we see the old and the new in fighting sea craft. In the days of the Spanish-American war the Oregon—shown in the background was one of the most formidable of our battleships. During the world war it served as mother ship to submarines. Compare it with the modern Connecticut. The submarine represents the latest development of the submarines. The conning tower is in the further end of the



UNITED STATES BATTLESHIP CONNECTICUT

Displacement 16,000 tons; speed 18 knots; armament: four 12-inch, eight 8-inch, twelve 7-inch guns, besides forty smaller, light and machine guns.



THE OLD AND THE NEW.

boat. The periscope is seen by its side. It is lowered into the submarine when it submerges. It is built to stand two hundred feet sea pressure, at that depth an automatic safety device opens and forces the water out of the ballast tanks and brings the submarine to the surface. It is also provided with a wonderful non-magnetic gyro compass. Notice the bow flippers on the deck—in the foreground of the submarine—looking somewhat like an anchor. When the boat submerges these spread out in the water and form the horizontal rudders. The rudders that steer it on the vertical plane are in the stern or far end of the boat. It is fitted with the latest listening devices and the most efficient engine made. It makes ten knots submerged and twelve knots on the surface.

THE TERRIBLE SUBMARINE WEAPON.

The weapon of the submarine was the torpedo, though many submarines carried large shell-firing guns as well. A number of torpedoes were carried, which were discharged through tubes located in the bow and in the stern of the boat. Any type of automobile torpedo could be used. The torpedo, manufactured by our government, is about seventeen feet long, cylindrical in shape, and eighteen inches in diameter. It is divided into three principal divisions, the head, the air chamber and the after-body. The head is made of bronze, and carries a charge of guncotton. The explosive is detonated by what is called the nose fitted into the head; when it hits the side of a ship the guncotton is exploded. This head is fitted to the air chamber by screws. The chamber itself is a hollow cylindrical body about eleven feet long. It is filled with air compressed to 2,100 pounds pressure to the square inch. This pressure is reduced by a valve to an engine working pressure of about five hundred pounds. The after-body of the torpedo contains the working mechanisms, engines, gyroscopic steering apparatus, and detached engines which control the rudders. All these are very delicate in adjustment.

THE MARVELOUS TORPEDO.

The torpedo can be adjusted to run any distance up to its limit of action, at any speed which in general depends on the distance it is to journey, and it can be run at any distance below the surface, so as to strike a ship below the water line. The torpedo is ejected or fired from the submarine by compressed air, but no sooner is it free from the submarine than its various machines commence to act, and it is driven to its mark by its own power. It is evident that a modern torpedo is a very expensive mechanism. The cost varies from one to five thousand dollars each.

WILL THE SUBMARINE BE ALLOWED IN THE FUTURE.

While the submarine proved itself a very efficient commerce destroyer, yet it was very successfully met by defensive measures. It is doubtful whether international law will sanction its method of attack in future wars. It is a sneaking assassin of the deep and its murderous assaults are made, generally, without warning. This may be lawful when used against war vessels, but as a commerce destroyer such action is nothing short of piracy. Though the submarine demonstrated its commerce carrying ability by bringing cargoes from Europe to America, it is self-evident that the submarine will never be able to compete with surface craft in this respect.

A TORPEDO DESTROYER.

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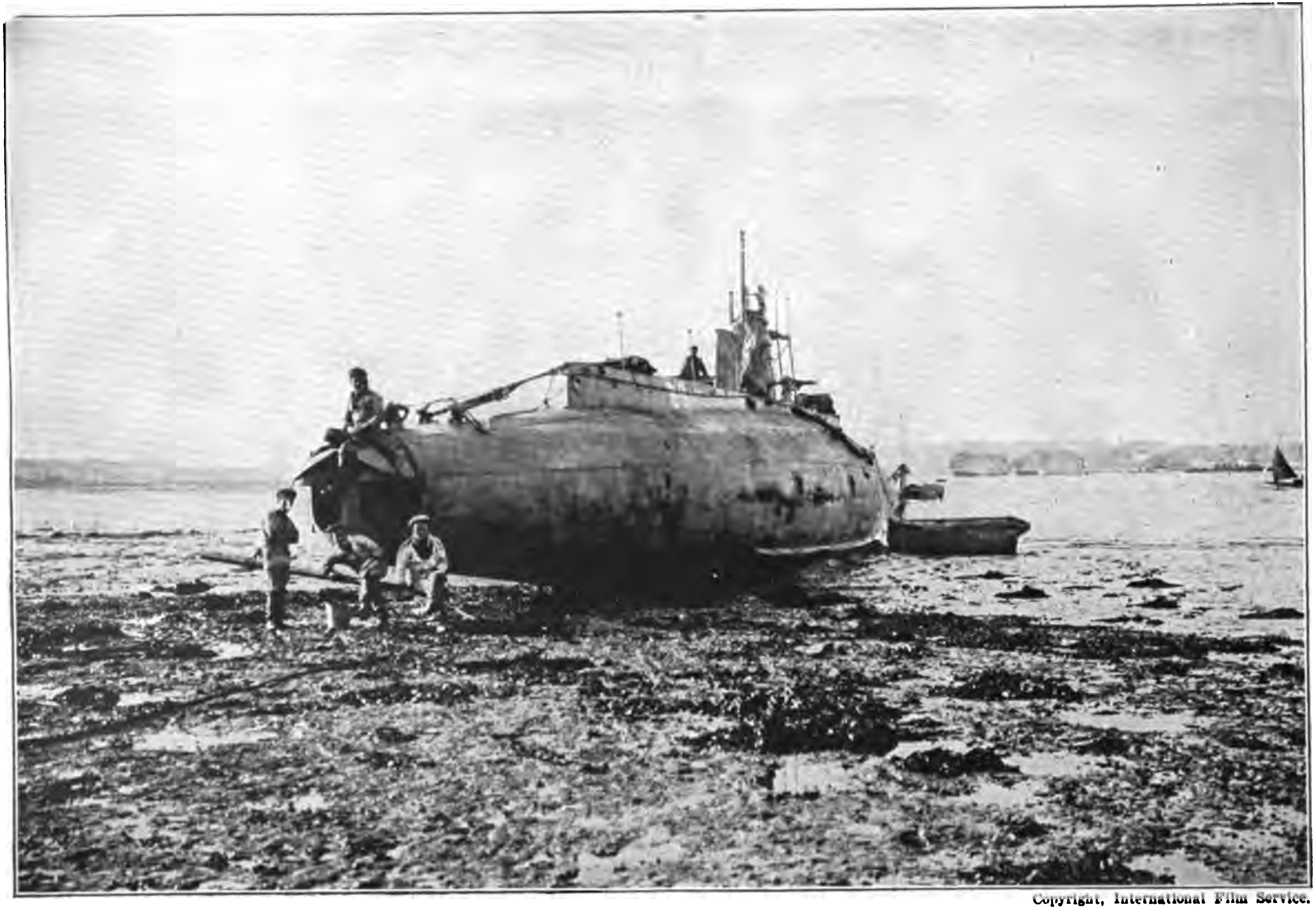
A STORAGE PLANT FOR TORPEDOES.

When submarines leave on a cruise, they carry from ten to twenty torpedoes each; a nation, then, that possesses several hundred submarines, must keep on hand several thousand torpedoes. Torpedoes are marvelous scientific machines, filled with several hundred pounds of high explosives, and cost from $3,000 to $7,000 each. After a torpedo has been fired, it travels by its own power, at any required depth, a distance of several thousand feet, keeping straight for its mark. Many hundred ships, with a tonnage of many thousand, have been sunk by torpedoes in the world war. Their use by submarines marks a new epoch in history.



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A BRITISH SUBMARINE.

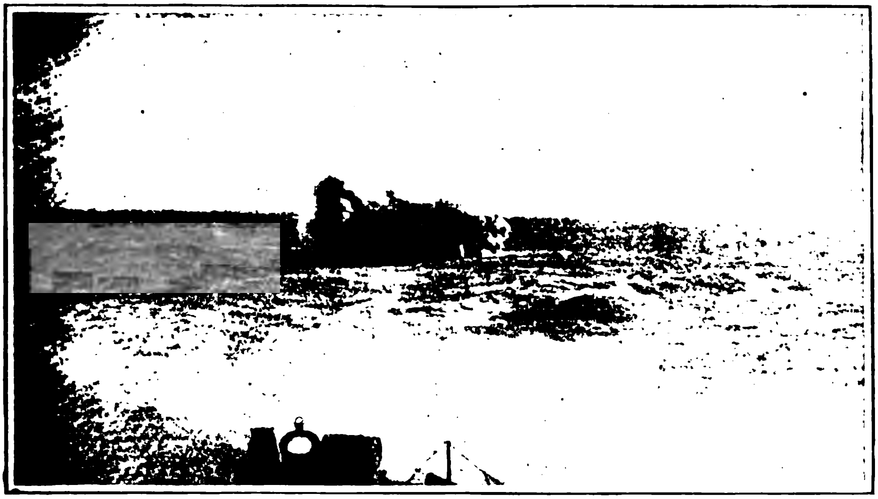
This illustration gives us an excellent idea of a submarine as a whole. It has been drawn upon the beach for repairs. Notice its general shape; its propeller, and the periscope. It is a small submarine. There are others much larger, some with nearly 1,000 tons capacity. Within, the submarine is a marvel of compactness. It must carry a crew, fuel and supplies of all kinds as well as torpedoes. Some also carry guns of considerable caliber, effective three miles. The "Deutschland" that visited the United States was a merchant submarine, carrying a cargo of several million dollars in value.

NEW MEANS OF DEFENSE.

The new weapon of war called for new means of defense, which gradually evolved during years of effort. As a mere protective measure steel nets stretched across the Strait of Dover and important harbors, thus protecting warships there anchored, were extensively used. Such nets protected New York harbor. But the one efficient means of defensive action was to cover, literally, the seas around the British Isles with destroyers, swiftly moving armored motor-patrol boats, and submarine chasers.

THE SWIFT DESTROYERS.

The new American destroyers are of 1,200 tons displacement, 320 feet in length, 32 feet beam, draft from 10 to 11 feet, speed 35 knots, driven by turbines, armed with four long 4-inch guns. Our fleet of destroyers was small, but very effective. Combined with the British destroyers and other ships mentioned they came near solving the problem. Not a transport crossed the ocean that was not met at a place agreed upon by several destroyers and escorted through the danger zone. They were constantly darting around the ship, cutting across the bow and stern, keeping tireless watch for submarines. The work of these trim little vessels in fair weather and foul, in summer and winter, by day and by night, forms the subject of one of the most interesting chapters in naval history. The magnitude of this service may be estimated when we read that during the war 10,000,000 men of all nationalities with all needed supplies, were escorted by the combined navies of the allies. Cruisers, destroyers and motor launches; mine trawlers and drifters, and other vessels were constantly at work; and observation balloons and seaplanes never ceased their vigils.



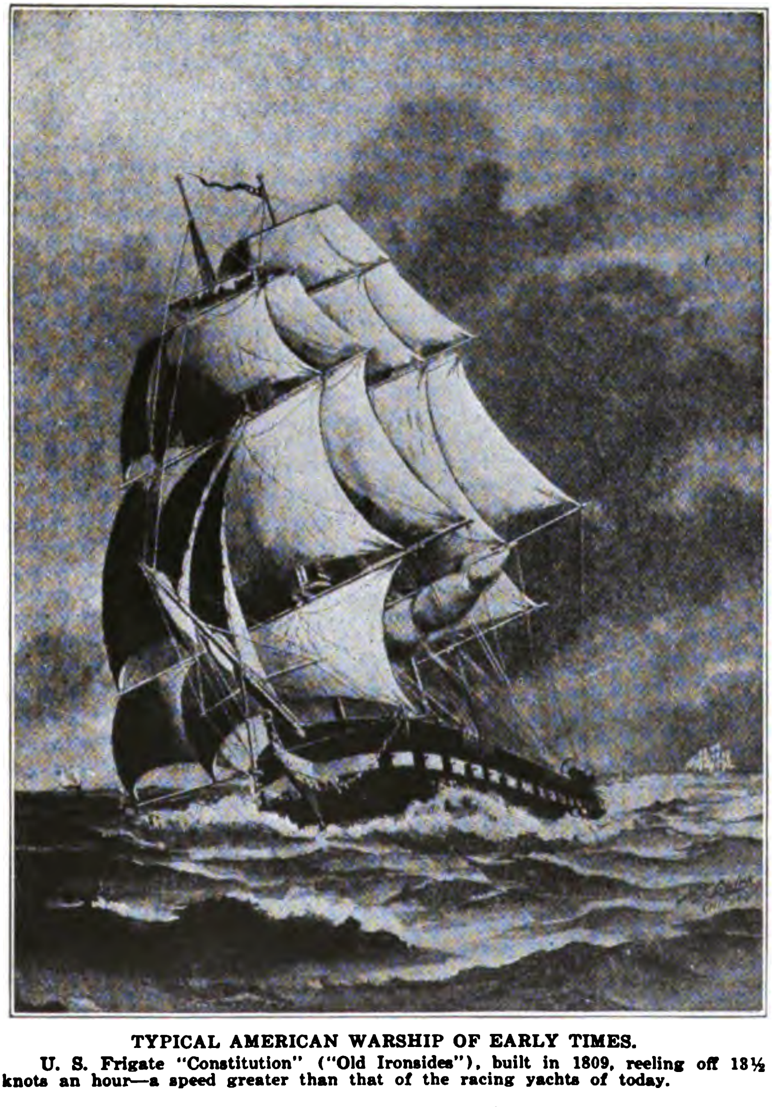
DEPTH CHARGE EXPLODING.

The depth bomb proved to be a most effective weapon against submarines. The explosive used was T. N. T. No submarine could withstand the effect of one of these exploding bombs unless about 100 feet away.

BOMBS THAT EXPLODE UNDER WATER.

The principal invention used to combat the submarine was the depth bomb which proved to be very effective. Such bombs are metallic cylindrical shells from two to three feet long, about ten inches in diameter, loaded with a large charge of high explosives.

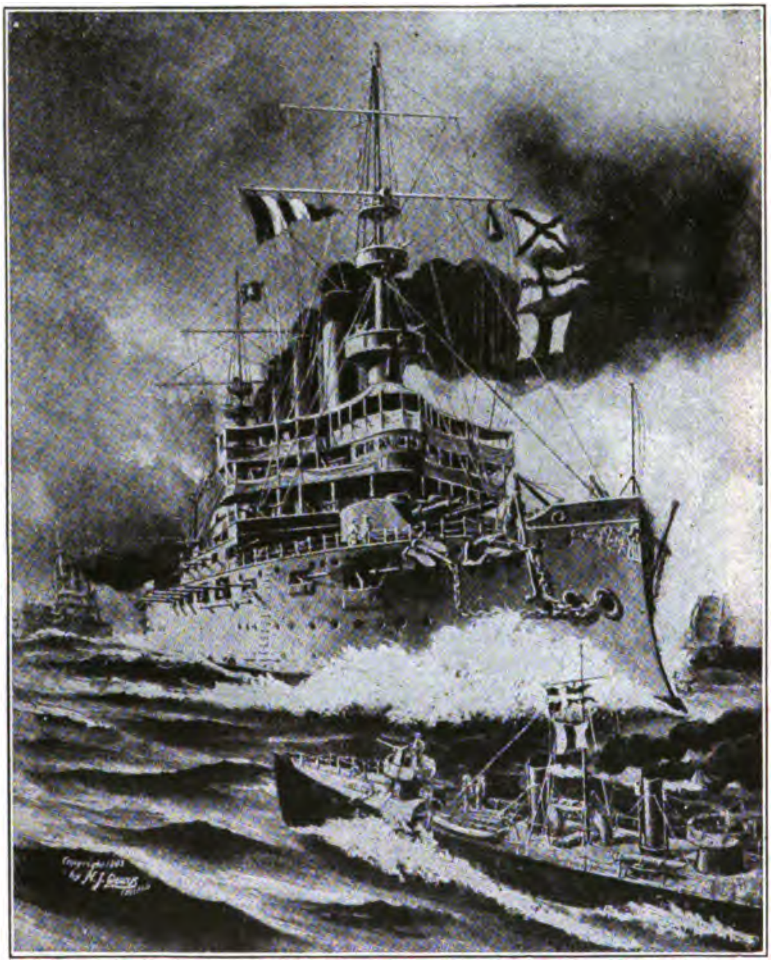
These charges grew rapidly in size. They began with 50-pound charges, before the end of the war 600-pound were being used. They are provided with a graduated disk by which they can be set to detonate at any desired depth, the explosion being caused by pressure of the water. They were carried on sloping runways at the stern of the attacking boat, from which they were released one by one and allowed to roll into the sea as needed. As the war continued, special guns for throwing these bombs some distance were invented. The United States invented a "Y" gun with which its destroyers were armed. This gun greatly increased the effectiveness of the depth bomb, for by it they could be hurled astern the destroyer, or to a distance on either side. A submarine in an awash position can submerge in about two minutes, but a destroyer moving 35 knots an hour can in that time cover more than a mile, and so has a fairly accurate knowledge of the submarine's whereabouts, and drops a bomb when near the spot. Water is incompressible hence if the bomb explodes near the submarine, the suddenly increased pressure of the water will destroy it. As a result it is asserted that it was a lucky submarine which showed itself or its periscope within view of a destroyer and survived the inspection. The depth bomb was greatly feared by the enemy submarine.



TYPICAL AMERICAN WARSHIP OF EARLY TIMES.
U. S. Frigate "Constitution" ("Old Ironsides"), built in 1809, reeling off 13½ knots an hour—a speed greater than that of the racing yachts of today.

SURFACE SHIPS OF A MODERN NAVY.

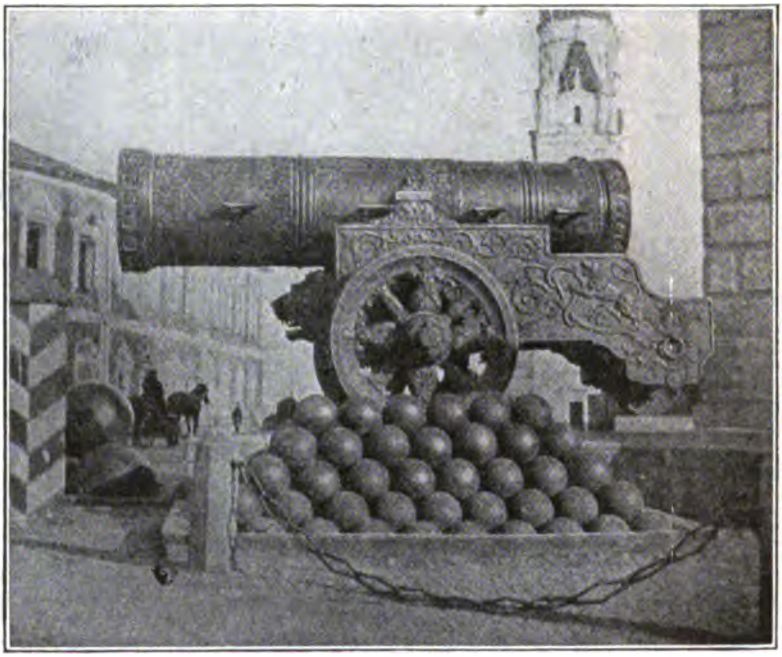
Ships for surface warfare in the modern navy follow in the main the old lines, but just as the battle ships culminated in the dreadnaughts and later into superdreadnaughts, so have the last named developed into immense floating forts that are as yet unnamed, they are not even described, but we can understand that they are of dimensions and power undreamed of in former days. The United States in 1918 authorized the construction of two 40,000-ton monsters. They will be 875 feet long, have a speed of 35 knots, and will carry 12 16-inch guns. A few years ago a battle ship of 32,000 tons was considered almost the limit of size. We have no reason to conclude the limit has been reached. Naval engineers assert that effective ships, even double the largest displacement of today, could be constructed. There are two types of first-class warships, the dreadnaught and the battle cruiser. The first is a ponderous, heavily armored, floating fort, of considerable speed, but designed especially to carry guns of the greatest calibre, the longest range, and the most penetrating power known in naval ordnance construction. Battleships of this class, like the British Queen Elizabeth, carry guns of long range but with tremendous smashing effect.



U. S. S. "COLORADO" AT FULL SPEED.

Description.—Length, 502 feet; beam, 59 feet, 6 inches; speed, 22 knots; horsepower, 23,000; battery, four 8-inch R. F. rifles, fourteen 6-inch, eighteen 14-pounders and twelve 3-pounders; cost, $3,780,000.

The dreadnaughts of the United States navy now in use are 624 feet in length, 97 feet wide, displacement 32,000 tons, speed 21 knots, armor plate 14 inches, that of the turrets 18 inches. They are armed with 8 16-inch guns, 22 5-inch guns, 4 3-inch anti-aircraft guns, and carry 2 21-inch torpedo tubes. They throw a ball weighing 2,400 pounds a distance of 27 miles, at the moment of its greatest height that ball is nearly eight miles in the air. A single broadside from these vessels sends 25,200 pounds of steel on its errand of destruction. This is nearly five times as much as could be sent on its way by the largest ship in the Spanish-American War. The firing charge is 900 pounds of the strongest powder made. Their full crews consist of 1,022 officers and men. The ships are equipped with oil burning engines. The United States battle ship New Mexico is propelled by electricity with results so satisfactory that our navy experts think this marks a great engineering advance, destined to effect battle ship construction the world over.



ONE OF NAPOLEON'S GUNS, IN THE KREMLIN, MOSCOW, RUSSIA.

This represents one of the "monster" guns of a century ago. It is a mere toy compared with a modern heavy gun that required several automobile driven trucks to transport it, the scientific appliance used in connection with it, and the large force of trained men that served it.

In the battle of Jutland, the British dreadnaughts commenced firing when the range was 20,000 yards, over 11 miles. As a result of that battle the tendency is to lessen the armor of the dreadnaughts but to increase the gun power and speed. It is asserted that some of the new ships of the British navy are armed with 18-inch guns, possess great speed, but they are comparatively lightly protected with armor. Such ships could commence an attack at a distance of fourteen miles, hurling a 3,000-pound ball and at the same time by their speed keep themselves beyond reach of the heavily armored enemy ship; but it is further reported that such ships are unable to stand its tremendous force of the recoil when the great guns are fired.

SOME MODERN CHANGES.

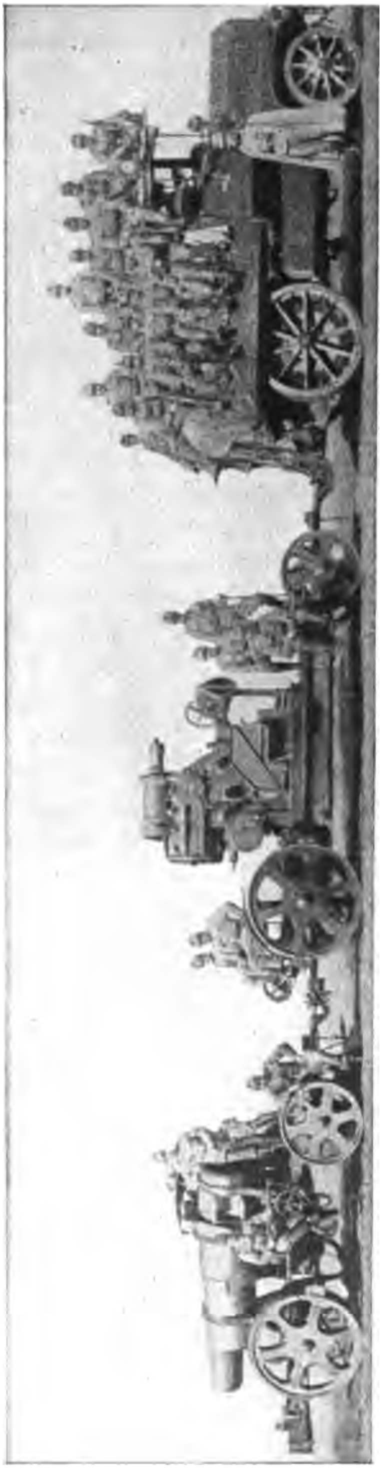
Contrary to the popular idea, the lookout in the crow's nest is not the man who finds the range and tells the gunners of a warship where to shoot. What was once the fighting-top of a battle ship, bristling with rapid-fire guns, is now the fire-control station, fitted with apparatus for range-finding and observation. An electrical switchboard connects this station with every primary battery. The heavy guns are inclosed in turrets, which are in reality little citadels of armorplate, surmounted by cupolas. The barbettes turn with the guns on cylinders.

A BATTLE SQUADRON.

In modern navy strategy, a typical battle squadron would consist of, say, four capital vessels of superdreadnaught calibre, together with eight armored cruisers of twenty-eight knot speed, twelve protected scouts of thirty knots, and a flotilla of thirty-five knots destroyers. In such a squadron, the vessels that must of necessity be possessed of extreme speed in order to do the work assigned to them efficiently—the destroyers and the scouts—are able to move as a unit at their highest maximum speed. Likewise, the armored cruisers are able to maneuver and fight as a unit, and the battle ship division can be sent into action, when the cruisers have prepared the way, with the certainty that no one vessel will outspeed any other and that all the vessels are equal in combative power. Similarity in speed in steaming radius, in offensive and defensive armament, and in class of the units composing a squadron, or of the squadrons composing a fleet, is what makes a naval force effective and efficient.

SPECIAL REPAIR SHIPS EMPLOYED.

Specially equipped repair ships to mend breaks and furnish broken parts are a necessary adjunct to the battle fleet. Every modern battle ship carries a blacksmith's forge and a small repair shop which makes minor



TRANSPORT OF HEAVY SIEGE GUNS.

repairs, but for serious breakdowns the elaborately fitted repair ship was used. To show their nature we will describe some of the more famous. The Ark Royal, said to be the only one of its kind in the world, was a floating airplane factory, and was equipped for mending seaplanes, airplanes, engines and parts, and was capable of building an entire aircraft. The Cyclops was a regular repair ship and carried three hundred skilled mechanics, a complete foundry where castings were made, and various repair shops. She could turn out a complete propeller for a big battle ship. In addition she carried a large distilling apparatus, sufficient to supply fresh water to a number of ships, an ice making machine and a big steam hammer. The Vulcan was a special repair ship for torpedo boats. She carried two huge cranes amidships, which were worked by hydraulic power and could lift a small vessel like a submarine clear of the water in half a minute. She carried launches which were used for mine sweeping, and below deck she could carry one hundred torpedoes and several hundred mines ready to hand to other ships as required.

UNSEEN DANGERS.

Mines are underwater explosive devices used to injure shipping at sea. They constitute iron tanks, filled with terrible explosives floating unseen near the surface. The number of mines used in the World War and their destructive nature were on a scale never before imagined. Modern mines are approximately spherical in shape and are provided with prejecting "horns" almost in the shape of drumsticks, concussion with which break small phials within, whose contents cause the detonation of an enormous charge of T. N. T. and T. N. X. explosives. Each mine is provided with a sinker, which drops to the bottom of the sea, and is attached to the mine by a cable or sounding line whereby the mine is kept at the intended depth beneath the surface. Then there is a variety of floating mines simply set loose to float in the track of commerce carrying ships.

Mines are placed in position by special ships known as mine layers, but the floating mines may be dropped from most any vessel, or from submarines. These last vessels placed floating mines off the coast of the United States in the last year of the World War. Submarines also placed mines in the Mediterranean and off the coast of Bombey. The greatest sea-mining operation in history was that of the allied nations in the summer of 1918. 122,000 square miles of sea from Scotland to near Norway, extending in a triangular form, to the Orkneys on to the north were heavily mined. 100,000 of these mines were manufactured in the United States. A special mine loading plant, with a capacity of 1,000 mines a day was established at Yorktown, Virginia. There is good reason to believe that many submarines ended their career in that mine field within a few months after it was formed.

SWEEPING UP THE MINES.

To meet this great menace to shipping, special vessels were engaged as mine sweepers so named because they swept up the mines. There were 3,000 mine sweepers at work off the coast of England and in the English Channel. The sweeping was patterned after the operation of trawling for fish. Two trawlers steaming abreast, at a certain distance apart, drag a weighted steel hawser between them that, upon striking the moorings of a mine bring it to the surface where it is destroyed by gun fire. Apparently simple means, but very dangerous to the men employed.

POWDER THAT MAKES NO SMOKE.

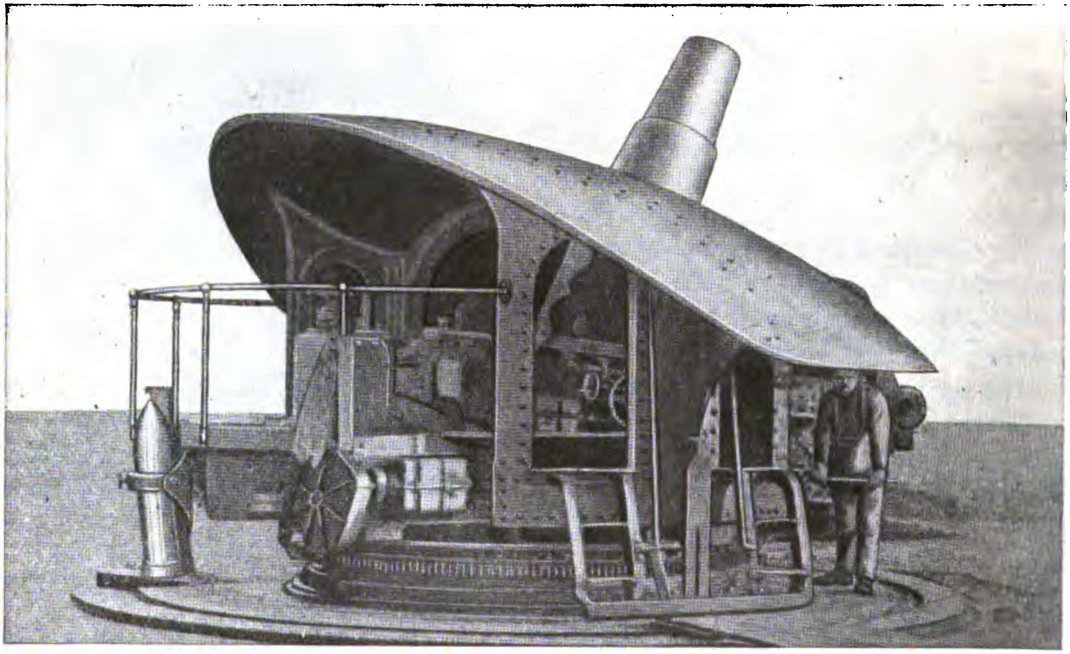
Powder is the explosive substance used in discharging guns. The modern powder is known as smokeless, because it gives off no noticeable amount of smoke or other vapor. Thus the location of the gun is not betrayed. It is also far stronger than the old powder. Nitrogen is a very inert or unsociable element. It does not readily unite with other elements and if coaxed into a combination, it is very apt to tear itself loose with an explosive effect. This is the reason why all kinds of powder contain some form of nitrogen compounds. In smokeless powder it is guncotton, that is ordinary cotton, or at least cellulose material, acted on by nitric and sulphuric acid, bringing the resultant nitro-cellulose into a gelatinous mass that is cut into flakes or forced through a machine and thus formed into cords, either solid or perforated. The resulting material is shaken in a receptical containing powdered black lead, or plumbage, and thus receives a metallic surface. Different varieties of powder are made by using slightly different nitro derivatives.

As employed in firing big guns the charges of smokeless powder are put up in little cloth bags of different sizes according to the guns. The sticks of powder are in the shape of small cylinders, pierced from end to end by a number of small holes. The purpose of this arrangement is to produce the proper kind of explosion. If the explosion be instantaneous, like that of nitro-glycerine, the shock would rupture the gun, but by this arrangement the explosion in the nature of an extremely rapid burning, thus producing increasing gas pressure that starts the shot gradually, and continues to accelerate its speed until it leaves the muzzle of the gun. Our government was just completing, near Nashville, the largest smokeless powder plant in the world when the war ended. It was to turn out 500,000 pounds of powder daily, it required for its use 4,500 tons of coal each day; and 65,000,000 gallons of filtered water, its full water supply being 100,000,000 gallons daily, enough water for the needs of a city of 1,000,000 people.

This shell is approximately 16.5 inches in diameter, nearly six feet in height. But larger shells were used by the Allies before the close of the war and in effectiveness it was surpassed by those discharged from the United States 16-inch guns on railway mounts used by General Pershing just as the war closed.

HIGH EXPLOSIVES.

Explosives are distinguished from powders by the fact that they are used as bursting charges in shells, grenades, bombs torpedoes and mines. The object in mind is to secure intense power, suddenly liberated so as to shatter the material in contact with the charge. The basis of all high explosives is also some combination of nitrogen. Explosives are frequently given names affording a clew to their composition, or they are named after their discoverer or the place where tested, as Lyddite, first tested at Lydd, England. Its base is picric acid, which results from the action of nitric acid (notice nitrogen) on carbolic acid. This is a powerful explosive and was formerly much used.



A HEAVY SIEGE GUN.

This formidable gun is on a concrete foundation. As the war developed, such guns were given mobile tractor mountings. The protecting device was replaced with some camouflage screen, it being necessary to conceal as far as possible its position from hostile aircraft. In general the use of heavy guns underwent a transformation, the result of experience gained in the war.

Nitro-glycerine is an explosive whose name indicates its composition, it results from the action of nitric acid and sulphuric acid on ordinary glycerine. This explosive is extensively used in quarrying, shooting oil wells and in many other purposes of peace. It is light yellow in color, sweet and fragrant in taste. Its manufacture, transportation and use is very dangerous. Dynamite is this same nitro-glycerine absorbed by some porous substance which may be of an explosive nature, or some inert substance, like charcoal; consequently grades of dynamite differ in strength and danger in handling.

TRI-NITRO-TOLUENE OR T. N. T.

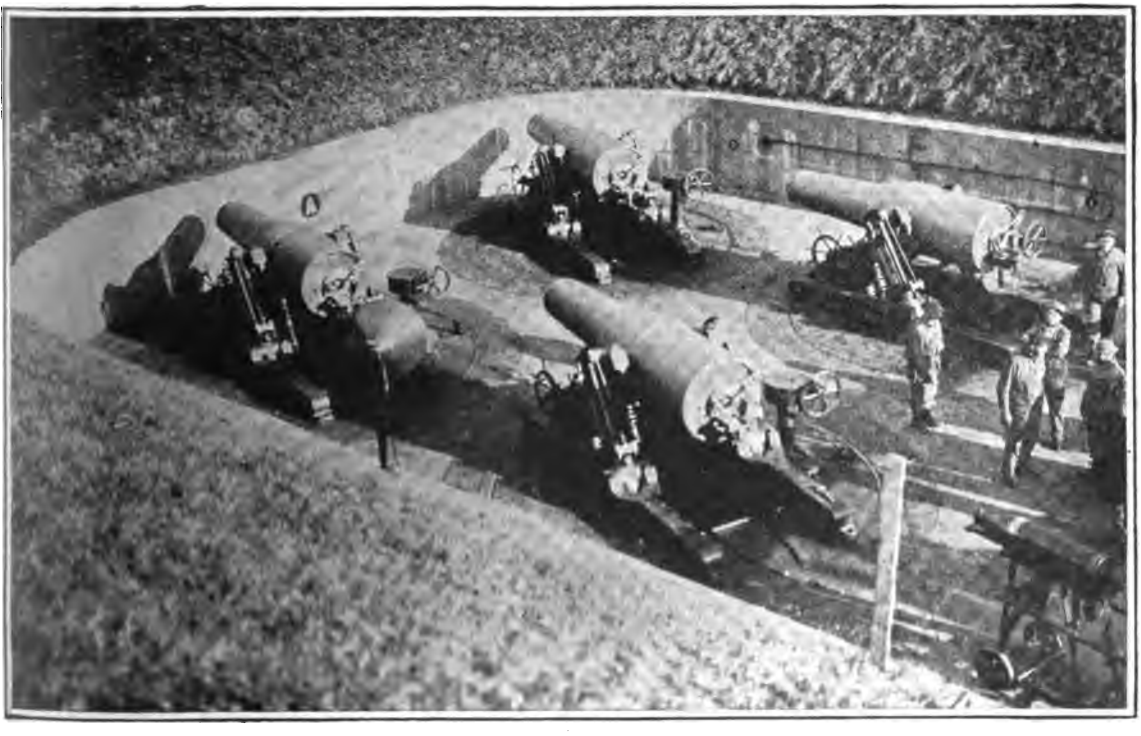
This is one of the latest high explosives invented, and possesses very great power. It is extensively used, especially in torpedoes, submarine mines, and in shells. It was this explosive that wrecked Halifax. As in other cases, nitrogen is the active agent. Toluol is a product of coal tar distillation. It is present to a small extent in ordinary gas, it escapes in the fumes of all coke ovens of the old style in which such fumes are not saved. In itself, it is a benzole compound in which nitrogen replaces some of the hydrogen in the toluol, which fact is reflected in the name,—tri-nitro-toluene. At ordinary temperature it is a white to a pale yellow, crystaline solid, but it melts at 80 degrees centigrade (176 degrees Fahrenheit). The needs for toluol were so very great that in 1918 search for another high explosive was begun which ended in the invention of tri-nitro-Xyoline or T. N. X., which is a first cousin of T. N. T., Xyol instead of toluol being nitrated. A plant capable of producing yearly 30,000,000 pounds of this new comer in the ranks of high explosives was constructed by the government.

IMPORTANCE OF COTTON IN MODERN WAR.

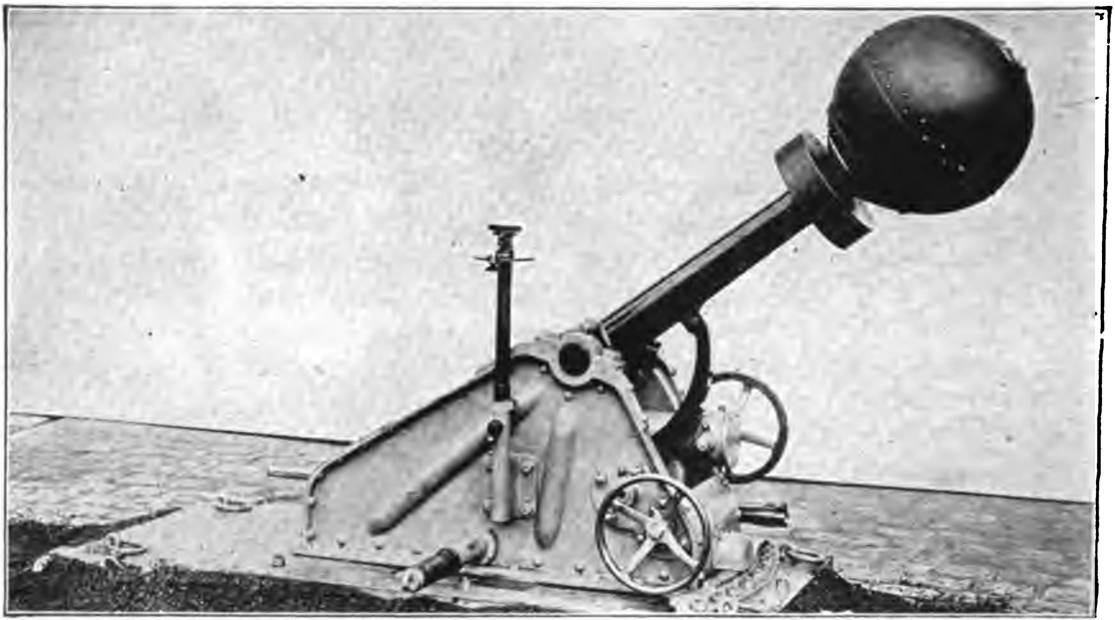
Since all forms of smokeless powders require for their production cellulose, and since cotton is almost pure cellulose, we can understand the importance of cotton in modern warfare, and the reason why cotton is classed as a contraband of war, that is a commodity that in times of war cannot be furnished by a neutral to one of the belligerents without danger of seizure while on the way by the other belligerent power.

IMPORTANCE OF NITROGEN.

The importance of nitric acid is still more apparent; without that acid we could not produce high explosives. Nitric acid is a chemical compound of nitrogen, hydrogen and oxygen. Nitrogen of course exists in a free state in the air, but in order to utilize it, it must some way be fixated, that is forced into a chemical union with other substances. One way of effecting such a result is by the aid of powerful electric currents. And now we understand why the government hurried the construction of its immense nitrogen fixating plants at Muscle



A SIEGE BATTERY.



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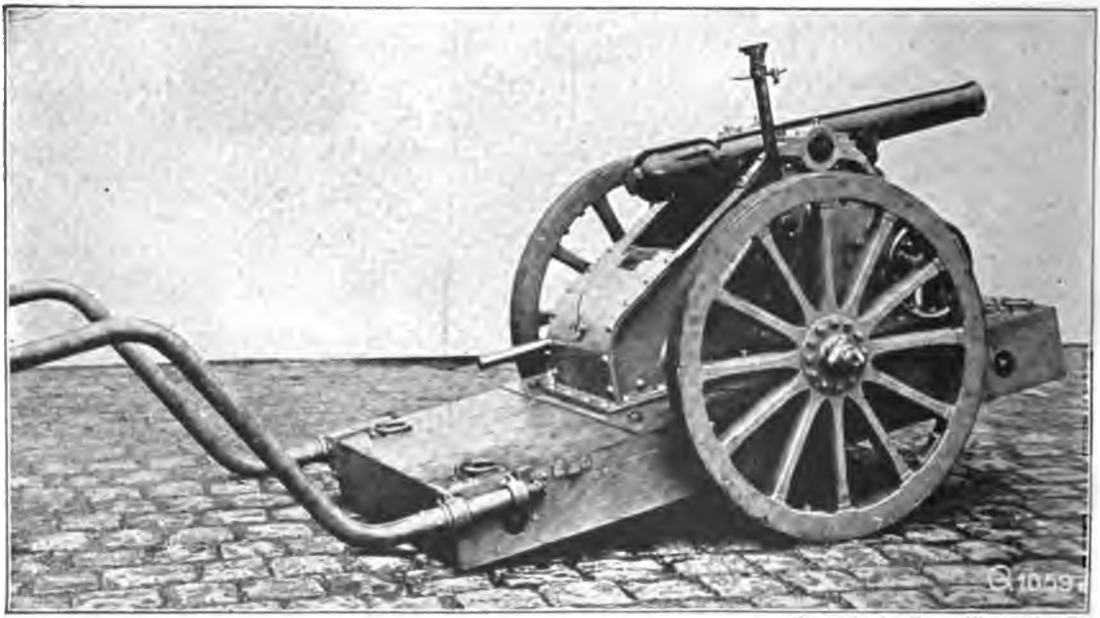
READY FOR DISCHARGE.

A gas-bomb throwing gun, ready for discharge. The bomb is attached to the metallic button at the muzzle of the gun. To the button is fitted a long rod that is placed in the bore of the gun and serves to steady the bomb in its flight. The button receives the impulse of the discharge. The bomb is filled with high explosives and liberates poison gas.



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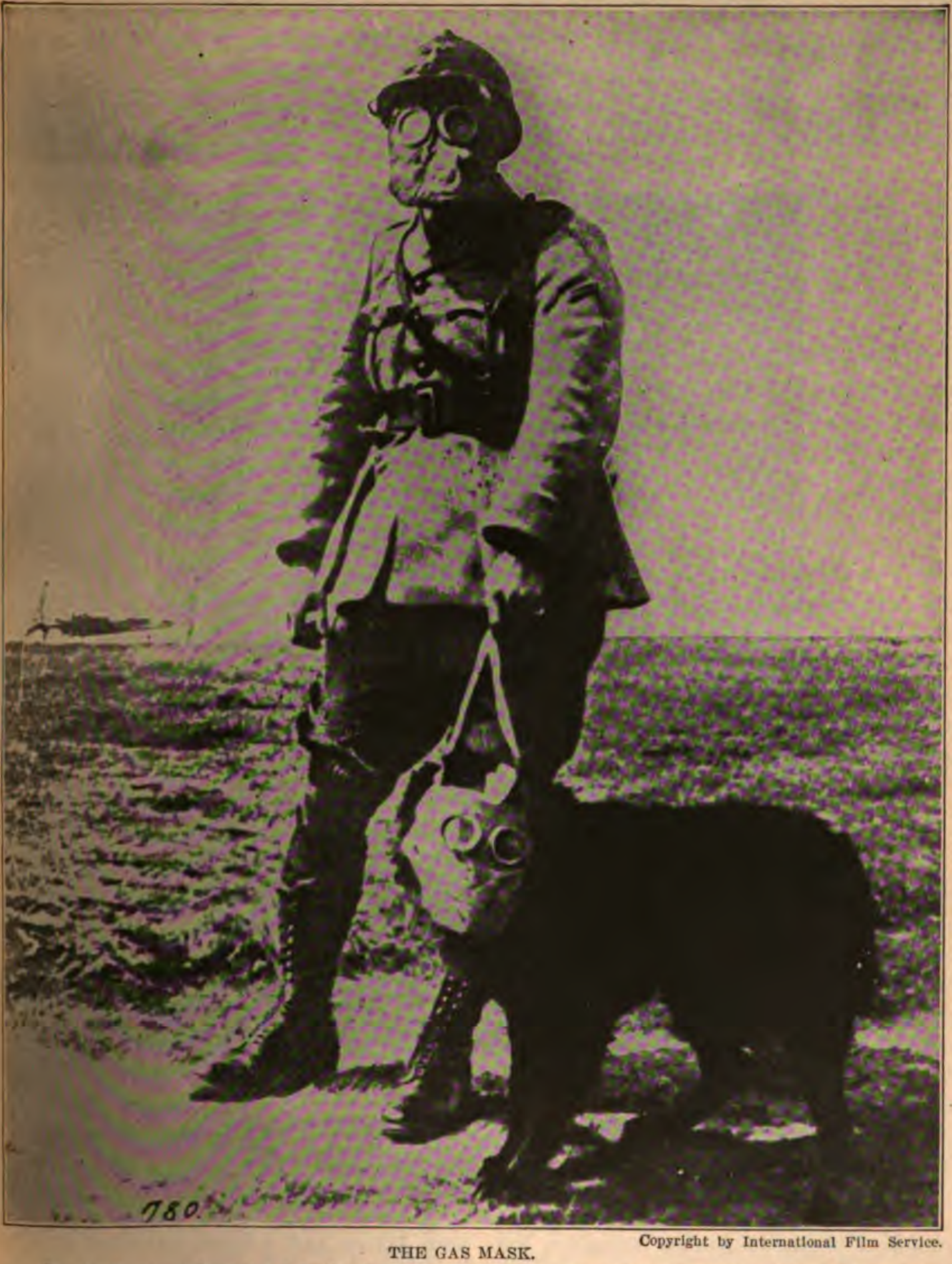
A GAS-BOMB GUN.

The gas-bomb gun, mounted on wheels for easy moving. It is used against aeroplanes and air ships. The bomb can be set to explode at a given distance and the fumes will kill all living beings within a radius of 100 feet.



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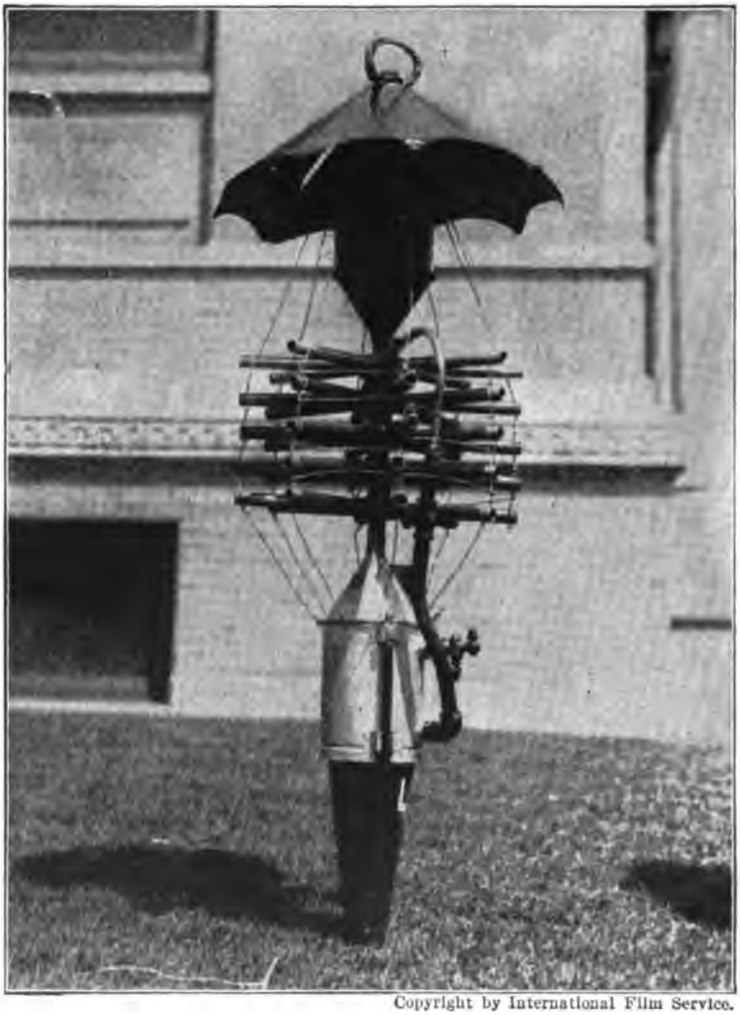
THE GAS MASK.

Gas attacks are so frequent and deadly along the various fronts that soldiers are provided with masks to protect the eyes and to purify the air. In this illustration are shown a soldier thus protected and a dog also wearing the mask. This is an after battle scene. Notice soldiers carrying wounded off the field. Dogs are used in many ways such as in finding wounded that are unable to attract attention, to carry messages between different parts of the line, and in scouting with soldiers on night patrol in "no man's land" between the trenches. They can detect the approach of an enemy patrol long before the soldiers can and silently warn their fellow scouters.

Shoals, Alabama, and Charleston, W. Va. Fortunately, fixated nitrogen is of equal importance in the production of fertilizers. Sulphuric acid is also necessary in making smokeless powder and high explosives, but the chemical elements used in its manufacture are more accessible.



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THE PARACHUTE LIGHTING DEVICE.

This is a device intended to light up the surrounding country at night to discover movements of troops, placing of batteries, etc. It is dropped from air craft. The parachute arrangement lets it fall with not too great force, sharp end down, which sticks in the ground. Contact sets off a most brilliant light that floods the immediate surroundings. To protect the light in position, the contact sets a cylinder revolving to which are attached rifle tubes that discharge a spray of shrapnel.

APPALLING EFFECTIVENESS OF MODERN SHELLS.

Shell is the general name for explosive projectiles. A shrapnel shell is one filled with bullets and a small bursting charge. The shell is caused to explode about 80 yards in front of the object aimed at, and the bullets are hurled on by the power of the explosion. In general, a shell filled with high explosives bursts upon striking its object, or by the action of the time fuse; its destructive effect is caused by the numerous small pieces into which it is broken, and by the earth, stone and other material which it throws up where it strikes. The battle fields of France were pitted with the ghastly shell craters of war. The shells of the French 75's are said to burst into two thousand pieces, which are very small of course, but flying with a high speed are capable of great destruction. In weight, shells vary from a few hundred pounds to those weighing more than a ton; some were six feet high, they were used in numbers never before approached in war. It is estimated that 20,000,000 were used in the battle of the Somme (1916); in the battle of Verdun more shells were used than in our entire Civil War. In the great offensive in March of 1918, more than half a million shells were used in one day. We can understand, then, the tremendous efforts of all the belligerents to make shells. One specification for shells in the United States called for one hundred million shells. The demand for steel to be used in shell making ran far into the millions of pounds. Five million tons of steel plate for shells were rolled by the steel mills of our country in 1918. Nine and one-half acres were inclosed under one roof of one shell factory in England.

STAR SHELLS FOR NIGHT ATTACKS.

Star shells are light producing shells. The use of searchlights on ships or battle fronts inevitably discloses the location of the force using them. In the star shell there is set afloat a single brilliant light, or star, attached to a parachute, which lights up the surrounding water or land. The movements of the enemy vessels or troops are plainly disclosed, but the forces firing the shell remain unseen.

THE DEADLY GAS SHELLS.

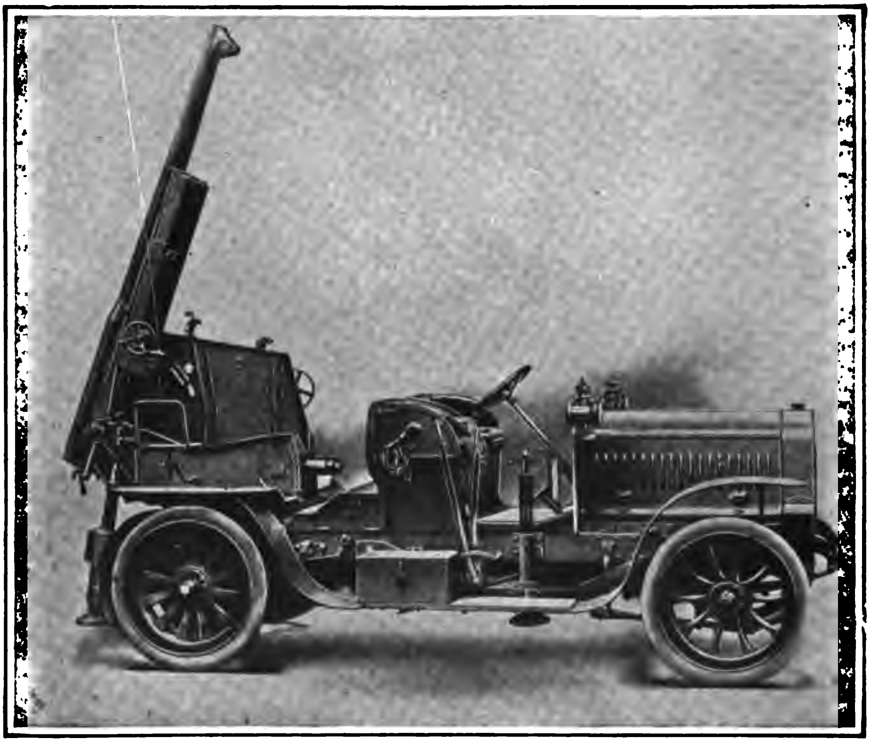
A new and terrible form of shells made their appearance in this war—shells loaded with asphyxiating gas. The first appearance of gas in warfare was at the battle of Ypres, April 22, 1915. The gas used was chlorine, generated in bombs, grenades, and other apparatuses, and allowed to drift with suitable winds into the trenches. But, before many months, regular gas shells were being used, fired from guns, caused to burst in, over, and around trenches; and different kinds of gases were employed, such as chlorine gas, tear producing gas, sneeze producing gas, and finally mustard gas. Gas shells were used in immense quantities. The United States at the close of the war, possessed, near Baltimore, the largest poisonous gas factory in the world, and was just beginning the production of the deadliest gas known.

GAS MASKS FOR MEN, HORSES AND DOGS.

This new weapon attack was met by the invention of a gas mask, that is masks to be worn over the face so constructed that air in its passage to mouth, nose, and eyes was filtered through certain chemicals that removed, or counteracted the gas. All soldiers engaged on the front, in trenches, etc., carried with them their masks, which were at once donned when the gas alarm was sounded. They were worn not only by soldiers but by horses and dogs as well. Connected with the uses of gas is the employment of flame projecting devices used for the first time in the World War though their use reminds the historian of certain customs of early ages in the use of Greek fire. Flame projections did not prove very effective.

ANTI-AIRCRAFT GUNS.

A new use of guns in modern war was that against aircraft, which rapidly grew in importance. The guns themselves differed from ordinary guns in their mounting, but were not materially different in other respects. They were mounted so as to shoot at aircraft which frequently flew at the height of several miles over the lines. Guns to reach to such a height were necessarily heavy, and so mounted that they could be fired nearly vertically. All naval vessels, destroyers, etc., were fitted with such guns, and they formed a part of the artillery equipment of every unit of organization in the army.

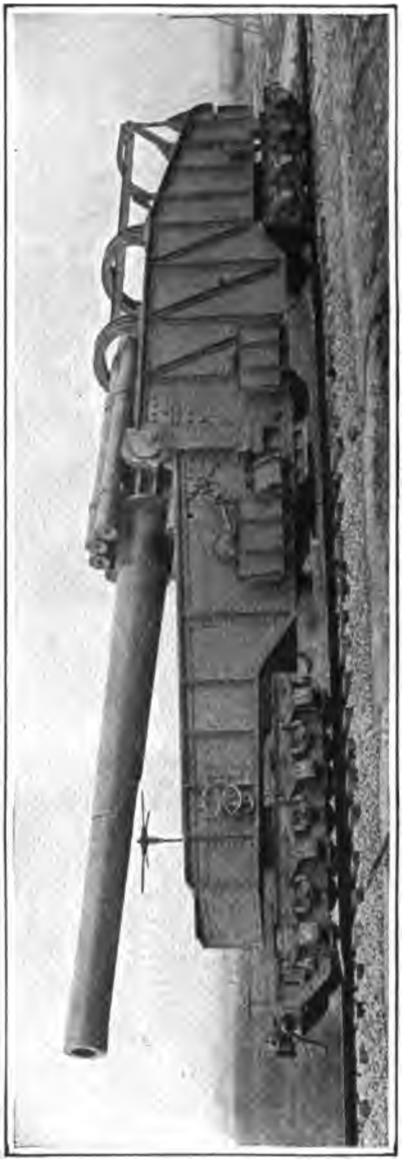


AN ANTI-AIR CRAFT GUN.

This is only one form of many anti-aircraft guns. This is provided with an automobile carriage. The only essential difference between such guns and other field pieces is their ability to be fired nearly vertically. They were intended for defense against aircraft. Their use became very effective as the war developed.

DESTRUCTIVE EFFICIENCY OF MODERN ARTILLERY.

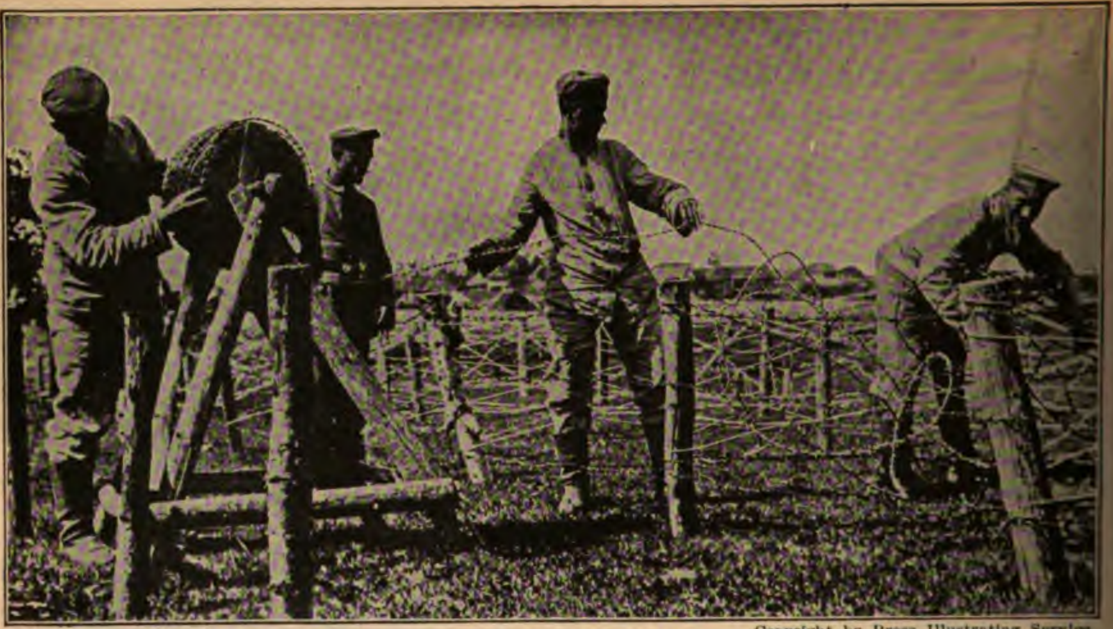
Artillery of all dimensions is employed in modern warfare, but on a scale not believed possible in earlier days. The greatest concentration of artillery ever witnessed was at the battle of Verdun, parelled, however, by the use of artillery in the great offensive in March, 1918. On that occasion, along a front of ninety miles, for much of the way every few yards a heavy gun was in operation, some of them throwing heavy shells a distance of six or ten miles.



A FOURTEEN INCH GUN ON A RAILWAY MOUNT

GUNS THAT REQUIRE A TRAIN OF RAILROAD CARS TO SERVE THEM.

A remarkable development was the use of guns of the very heaviest calibre on railroad mounts. In former wars the 6-inch howitzer was considered the heaviest piece that could be used in field operations. Before the end of the World War the most powerful guns in existance, including the 21-inch gun of the French were in the field. The United States employed several batteries of 14-inch guns on a specially prepared railway mount. Thus mounted our heavy guns could be moved freely over the railroads of France, and when in position they hurled their projectiles approximately a distance of 30 miles reaching points far in the rear of the enemy lines. It required a good sized train to move a single gun. Twelve cars were necessary. There were machine shop cars, armored ammunition cars, kitchen, berthing, crane, and wireless cars. All this would have been considered impossible, out of the question, in earlier wars. It demonstrates what science can do in modern warfare. We barely had a chance to show what such guns were capable of doing, but one in position near Verdun was able to send shells into Montmedy—a vitally important railway center for Germany—twenty-two miles distant. It had been considered safe from bombardment. A single shot from this gun completely destroyed three railroad tracks for a distance of over one hundred and fifty feet, leaving nothing but a deep shell hole to mark the spot. We also had 16-inch howitzers. These excessively heavy guns could only be moved by railroads on specially prepared cars. When the war opened the world was surprised at the immense guns the Germans were using in Flanders. They were fixed guns fired from concrete foundations. They were as child's playthings compared with the mobile heavy guns on railroads mounts used by the United States at the close of the war. We also had 8-inch howitzers propelled on caterpillar mounts that could go right along with the army and thus were always ready for business. Further, we employed a special tractor to pull heavy guns. These tractors went right



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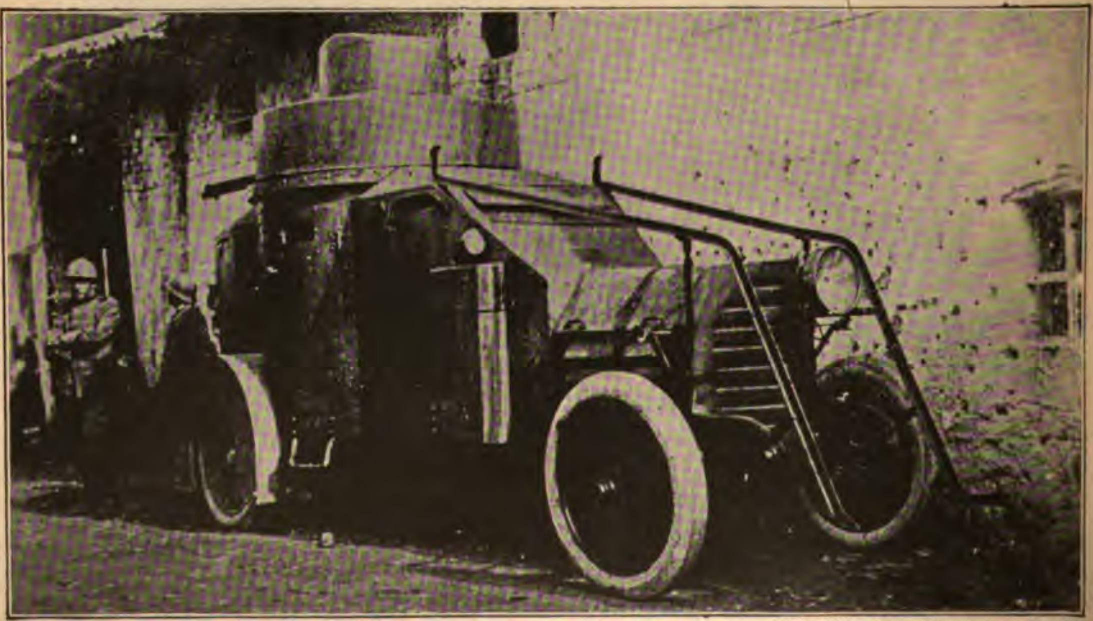
BARBED WIRE DEFENSES.

Here is represented one of the uses of barbed wire in war. Often trenches and important positions are defended by three or four lines of wire entanglement; and they are often charged with powerful electric currents. We can understand why advances are attended with such furious bombardment. It is not of much use to cut the wires; they must be shot to bits and blown away.



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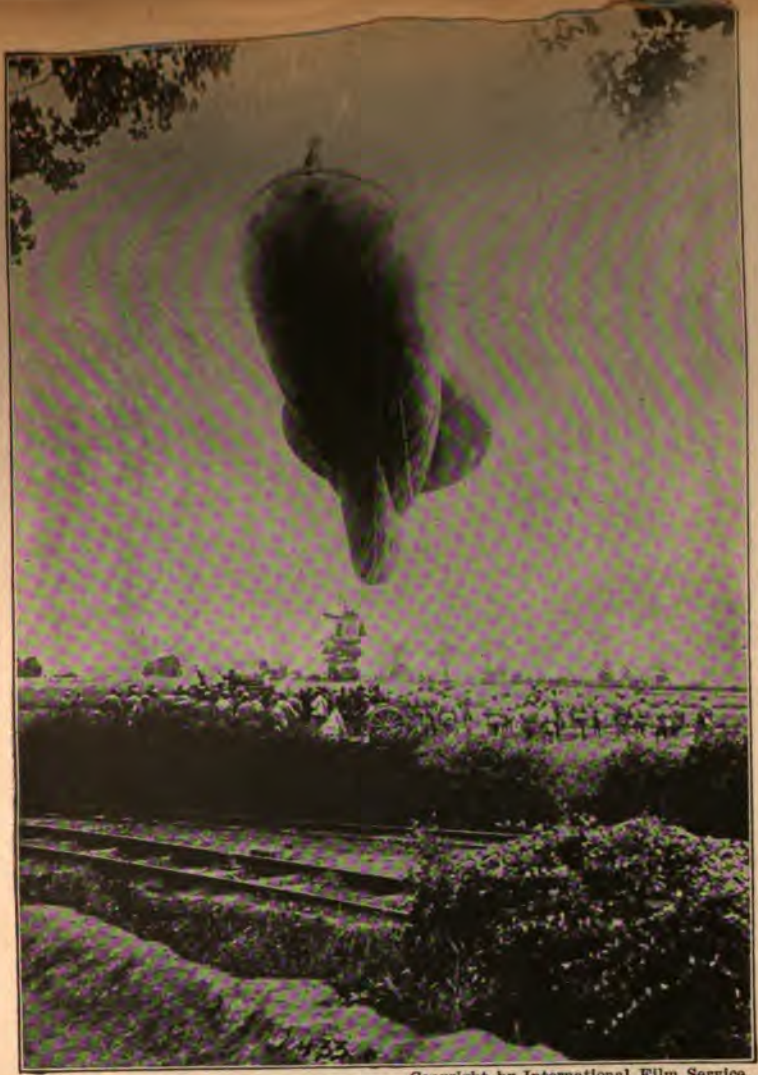
ARMORED MOTOR AND WIRE CUTTING MACHINE.

This is an armored motor car with wire cutting scissors in front designed to cut away wire entanglements defending trenches. It has been found in practice, however, that the only effective way is to literally blast such entanglements to powder by terrific bombardments such as precede all advances on the front.



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AN OBSERVATION BALLOON.

This observation balloon is shaped in accordance with scientific research and is semi-rigid, that is to say, its general shape is controlled by a framework. It is a captive balloon, held in position by ropes. Notice the observation car suspended below. There are parachutes provided for descent in case the balloon is shot down.

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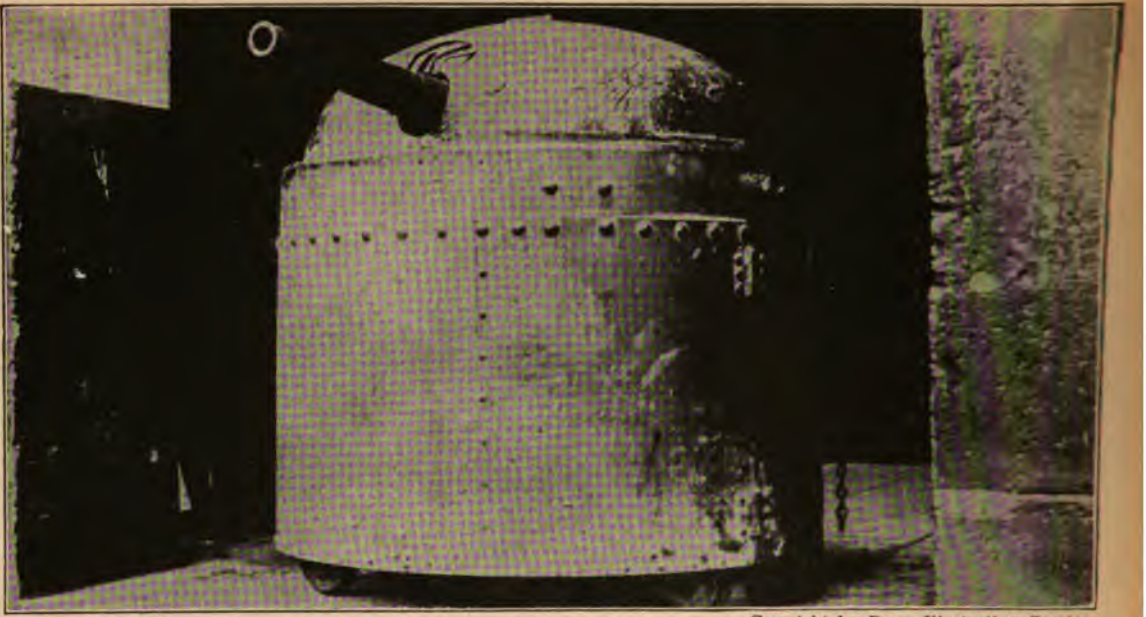
A FLAME THROWING ATTACK.

This represents the use of flame throwers in a modern battle. The thrower looks somewhat like a fire extinguisher and is hung on the back of the soldier, an extension held in the hands throws the flame, deadly to the foe. Naturally, the air is full of smoke, but the gas liberated is not poisonous; so this attack must with a gas attack. The poison gas is generated a distance in



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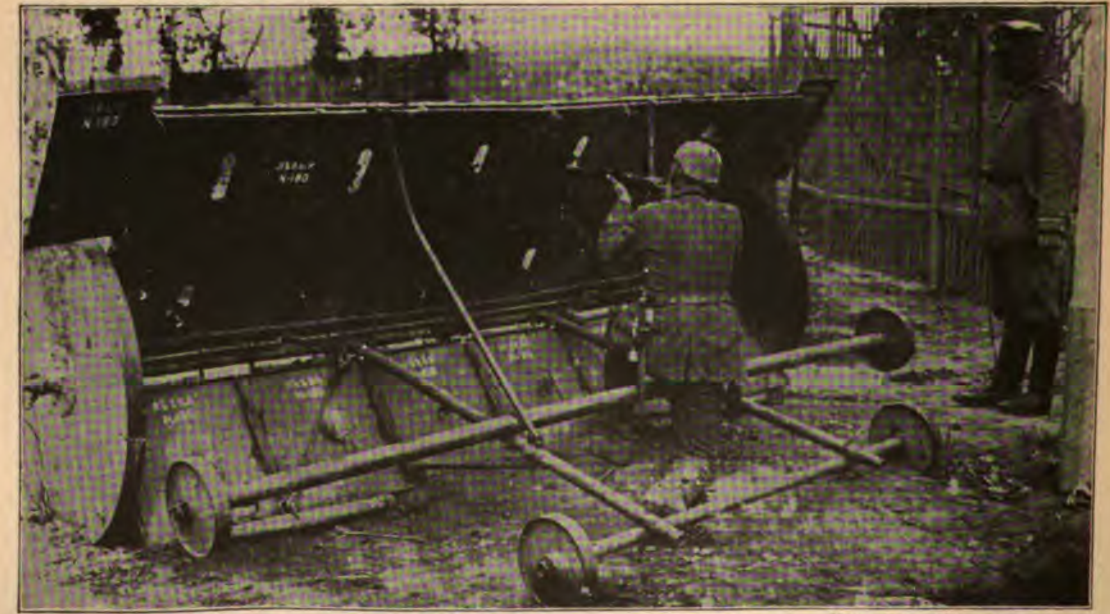
A REVOLVER GUN AND CUPOLA.

Machine guns are very effective since they can pour out a veritable stream of shot. It is the object of the enemy to disable such a gun and the crew serving it. This represents a revolver gun in an important place protected by a cupola of heavy iron plate.



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TRANSPORTABLE BARRICADE.

A transportable iron barricade, mounted on wheels, used to protect soldiers on the firing line. The rifleman kneels behind the barricade and fires through the portholes. Though used to some extent, they have not proved a success, since they can be so easily knocked out of position by a well placed shot.

through mud holes, shell craters, over logs, through stone walls, or any other obstruction.

FORTS OUT OF DATE.

The immense siege guns used at the beginning of the war, the most effective, mobile heavy guns used in the closing months showed that forts of the old style are out of date. Verdun was defended by some of the very strongest of modern forts, after the Belgian forts had been demolished in the first few weeks of the war, they were quietly dismantled and the defense of Verdun intrusted to trenches on hills miles distant. We heard much of the great fortifications of Metz confronting General Pershing just before the armistice was signed. His 16-inch guns would have demolished them about as easy as tumbling down the child's house of cards.

AUTOMATIC GUNS THAT FIRE HUNDREDS OF BULLETS PER MINUTE.

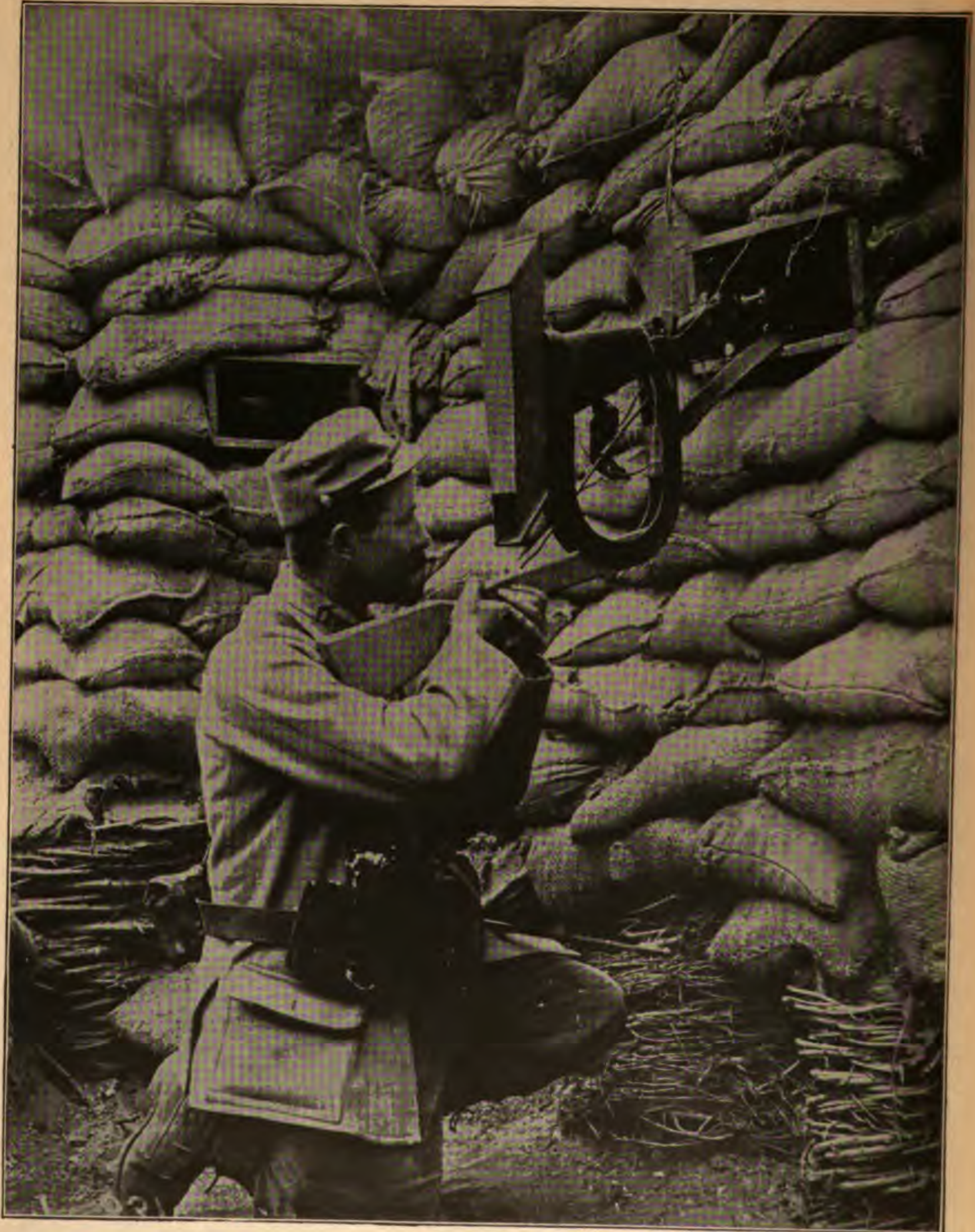
There is little new on principles involved in modern machine guns. They are to the old machine guns what any finally perfected machine is to its crude first forms. The Gatling gun, Mitrailleus, and Hotchkiss guns of earlier years gave place to modern forms —like the Colt, Browning, and Lewis guns in this country and a variety of forms that were used abroad—all were on the same general plan, all single barreled, highly automatic in character, capable of sending forth a literal spray of bullets, from two hundred and fifty to three hundred per minute. The heavier guns, with a tripod mounting required a crew of several men to operate; other lighter guns could be operated by a single gunner. The light Lewis machine guns, stripped of their cooling attachments, extensively used on airplanes, looked something like the toy airgun used by children, but they were extremely effective guns.

As a result of experience gained in the World War, machine guns were rapidly becoming the principal infantry weapon as distinguished from artillery proper. In the later battles the combatants faced thousands of such guns. Every mine crater, shell hole or even tree sheltered a machine gun and its crew. They were used in immense quantities. They so demonstrated their usefulness that many military students think the military arm of the service will be differently armed and maneuvered in future wars.

MODERN BATTLES VASTLY DIFFERENT FROM FORMER ONES.

A battle is conducted along entirely different lines than in former times and presents an altogether different scene than those of battles in former wars. The front is any where from 30 to 200 miles in length. That means that along that entire distance guns are roaring, airplanes are flying back and forth, observation balloons are taking notes, here and there barrages of shot and shell, regular metal curtains, are protecting the advance of the infantry. The first battle of the Marne was along a front of over 100 miles. Frequently in the summer of 1918 the entire front from the English Channel to near Metz was engaged, fractions of it at other times, the great offensive of 1918 opened along a front of 90 miles.

The commanding general is perhaps a hundred miles distant, but he is in instant telegraphic, telephonic, and wireless communication with every officer in command of every important unit at the front. What dispatch riders there are at the front are not on prancing horses, but business-looking motor-



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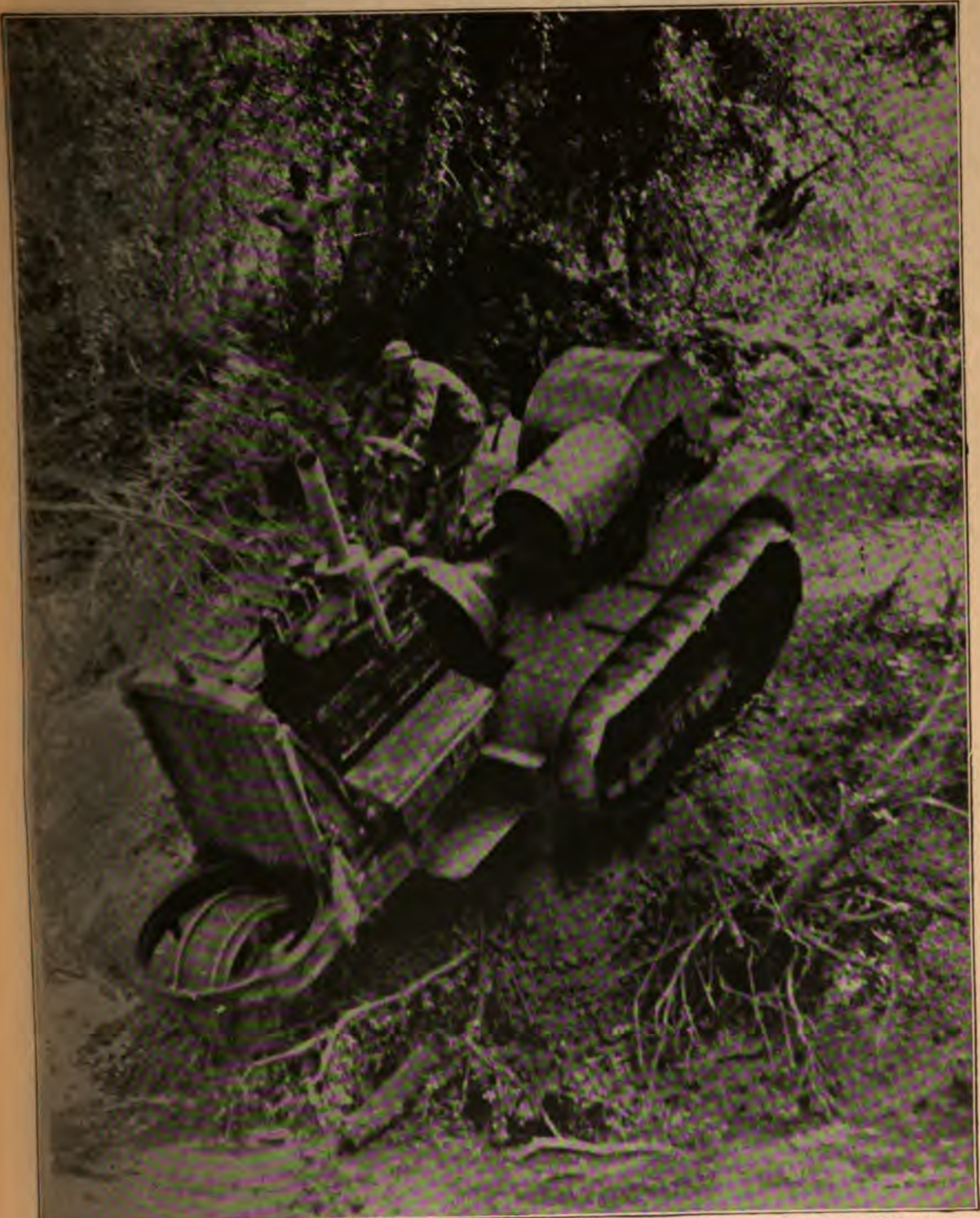
A PERISCOPE RIFLE.

All are familiar with the use of the periscope on the submarine. The same principle is used in many different ways in the trenches for the convenience and protection of the men using them. In this illustration the soldier is aiming his rifle by means of an attached periscope. Notice that no part of his person is exposed to fire; the trenches are so near that such exposure would be dangerous. They are also used for observation purposes.



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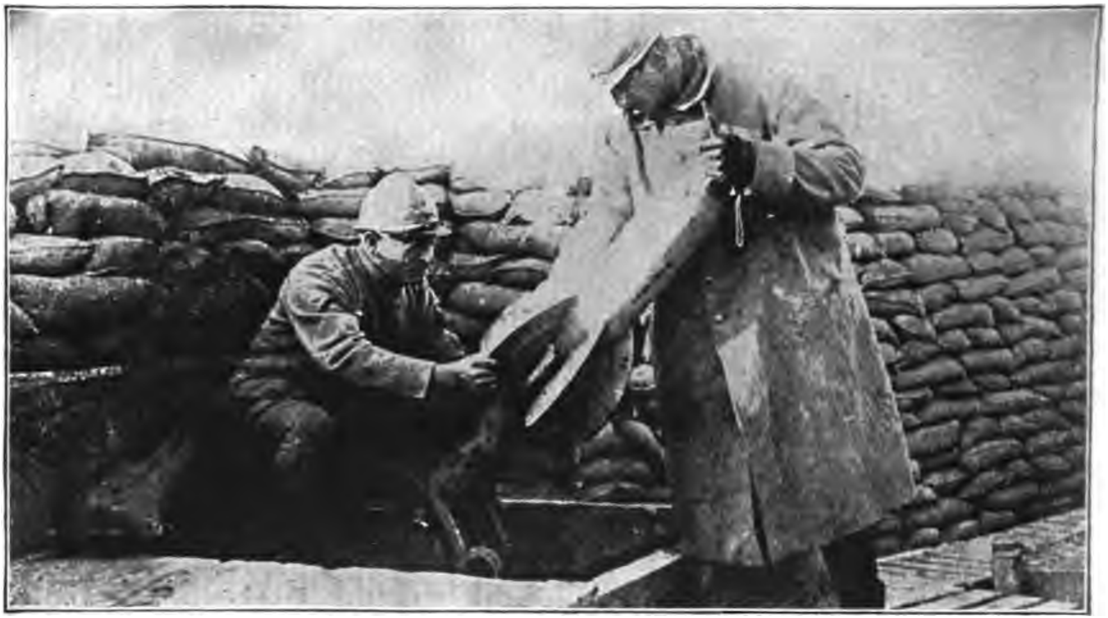
THE ARMY TRACTOR.

The special mission of this tractor seems to be to emancipate the army mule. It qualified for its work by drawing a train of sixteen wagons loaded to their capacity, a distance of more than 150 miles, over rough ground at an average speed of three miles per hour. It is seen about to ford a small stream. It walks right along and the wagons obediently follow; a few more or less seem to make no difference. One advantage is the absence of unnecessary words from army teamsters.

cycles, or perhaps it is only a quick-witted dog racing along as unostentatiously as it can. It makes no difference to the modern Sheridan, whether he is twenty or fifty miles away.



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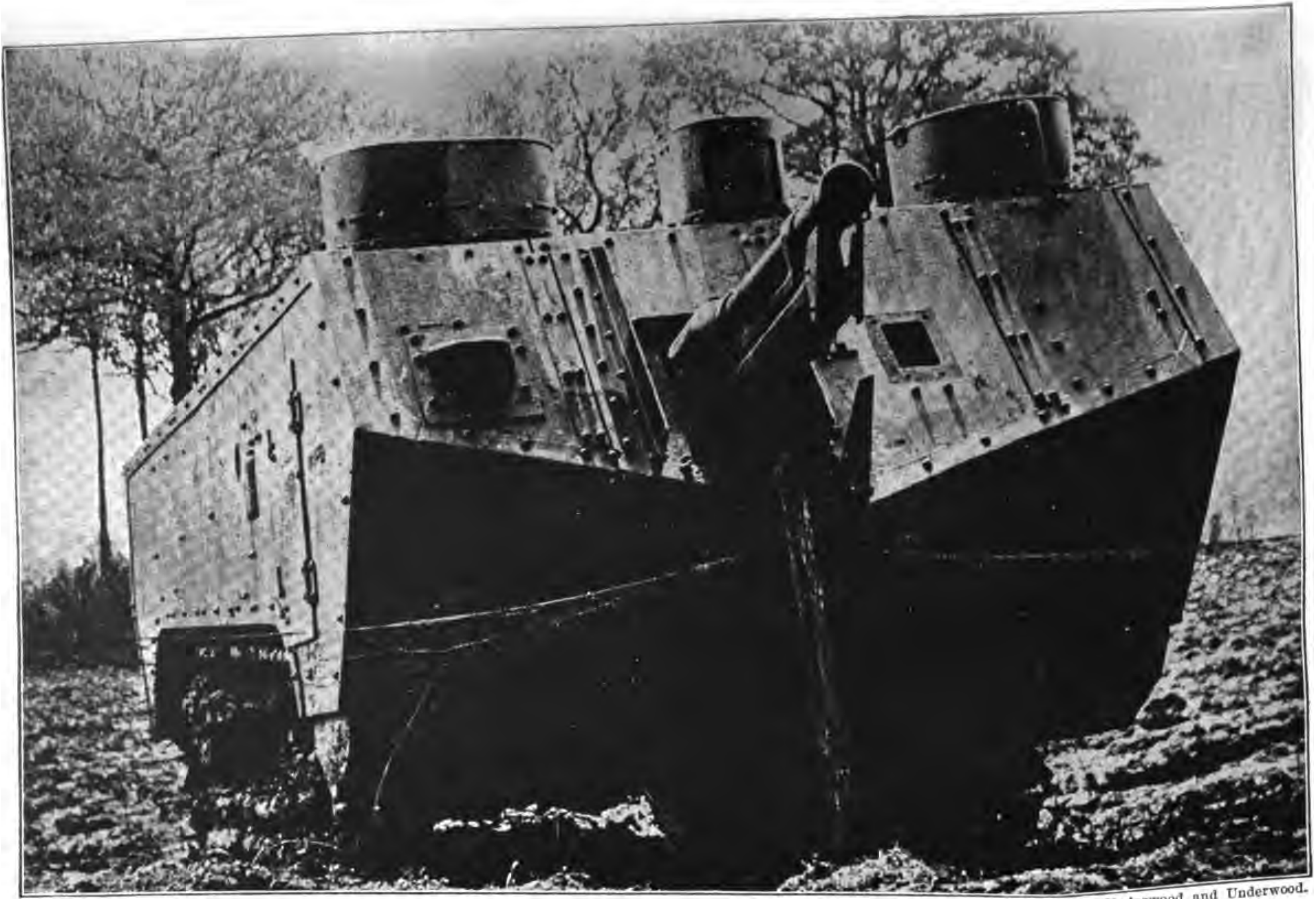
GETTING READY FOR ACTION.

The soldiers are placing an aerial torpedo in a trench mortar, preliminary to discharging it. The torpedo itself is an explosive shell, but notice the difference between it and a shell thrown by regular heavy artillery. The mortar will throw it a short distance only, perhaps a hundred yards from trench to trench. Notice the general shape of the torpedo. You understand why the soldiers call them flying pigs. The flanges keep it in the line of flight. The tail piece is placed in the mortar and will receive the force of the discharge. The shell will light on its "nose" and the impact will discharge the high explosives it carries. One of the soldiers is sitting on the mortar.

HUNDREDS OF MILES OF TRENCH PROTECTED FRONTS.

Military operations are those of trench warfare, or war in the open. In early wars armies entrenched themselves, or dug themselves in, but never on such a scale as in the World War. Trench warfare began after the first battle of the Marne, and then was adopted on all fronts, and remained the feature of warfare until the closing year of the war. In France there were thousands of miles of trenches, extending from the Vosges Mountains to the English Channel, in an irregularly curved line convex toward Paris. There was not simply one line but several parallel lines, and an intricate system of cross-connecting trenches. Trenches were not simply ditches; at places, they were fortified with bags of sand and connected with underground chambers, rest chambers, officers' headquarters, etc. The trenches were constantly occupied by front line troops.

Back of the front line trenches, were other bodies of troops, batteries of guns in as concealed positions as possible. There were lines of observation balloons and aerodromes where flying machines were constantly arriving and departing, they were immense ammunition dumps where many thousands of shells were parked.



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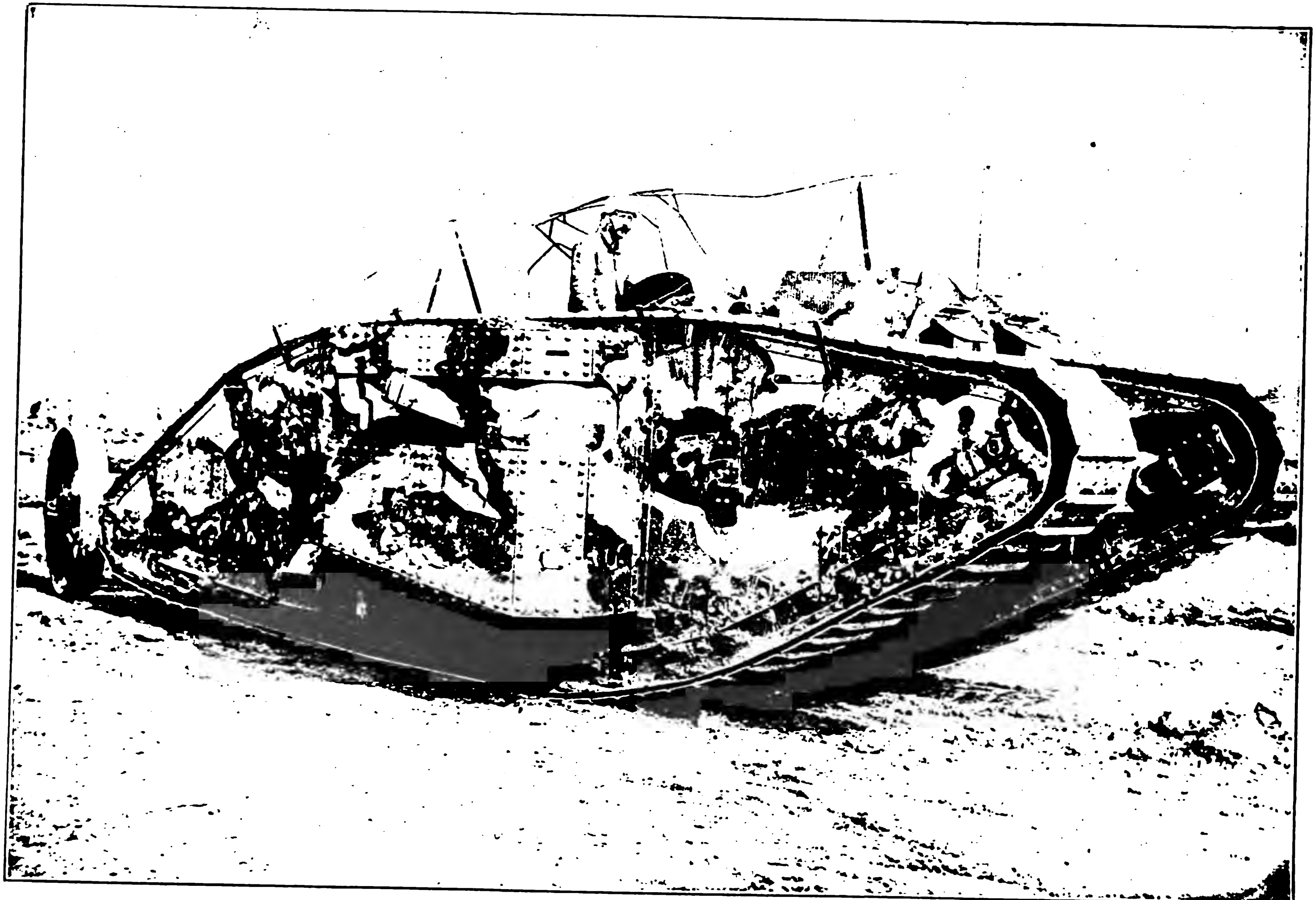
A FORTRESS ON WHEELS.

Beginning with the armored automobile of 1914, we have come to veritable traveling forts. Here is represented one of the largest of its kind. Notice the long range howitzer projecting in front. There are revolving turrets on the roof. By sliding sections of the plating, portholes are uncovered from which machine guns and rifles can be fired. These machines are driven by caterpillar chain drives. They will clamber over any kind of ground, cross trenches and pass into and out of shell craters. They constitute a remarkably effective fighting machine.



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A CAMOUFLAGED BRITISH TANK.

Illustrating the use of armored automobiles in war. Such armored cars are called tanks. The crew that works the guns and drives the machine is on the inside, protected by heavy armor plates. Notice the painting on the sides; it is not for ornament but for concealment. The idea is to make the sides of the car look as much like the surrounding country as possible, so that air craft, from their great height, will not notice it. Such an ornamented car is said to be camouflaged. Tanks move slowly but are very effective, since they can climb in and out of trenches, pay no attention to barbed wire entanglements, and rain shrapnel on all sides.

BARBED WIRE.

For the first time in history, barbed wire became a powerful agent of defense. Many thousands miles of such wire were strung up and down the trenches in France. Our illustration shows how it was used. The wires were often charged with electricity so that mere contact was dangerous. The great need of barbed wire may be estimated from the fact that during 1918, 250,000 tons of this material was supplied by the steel mills of the United States.

TRENCH BOMBS AND TORPEDOES.

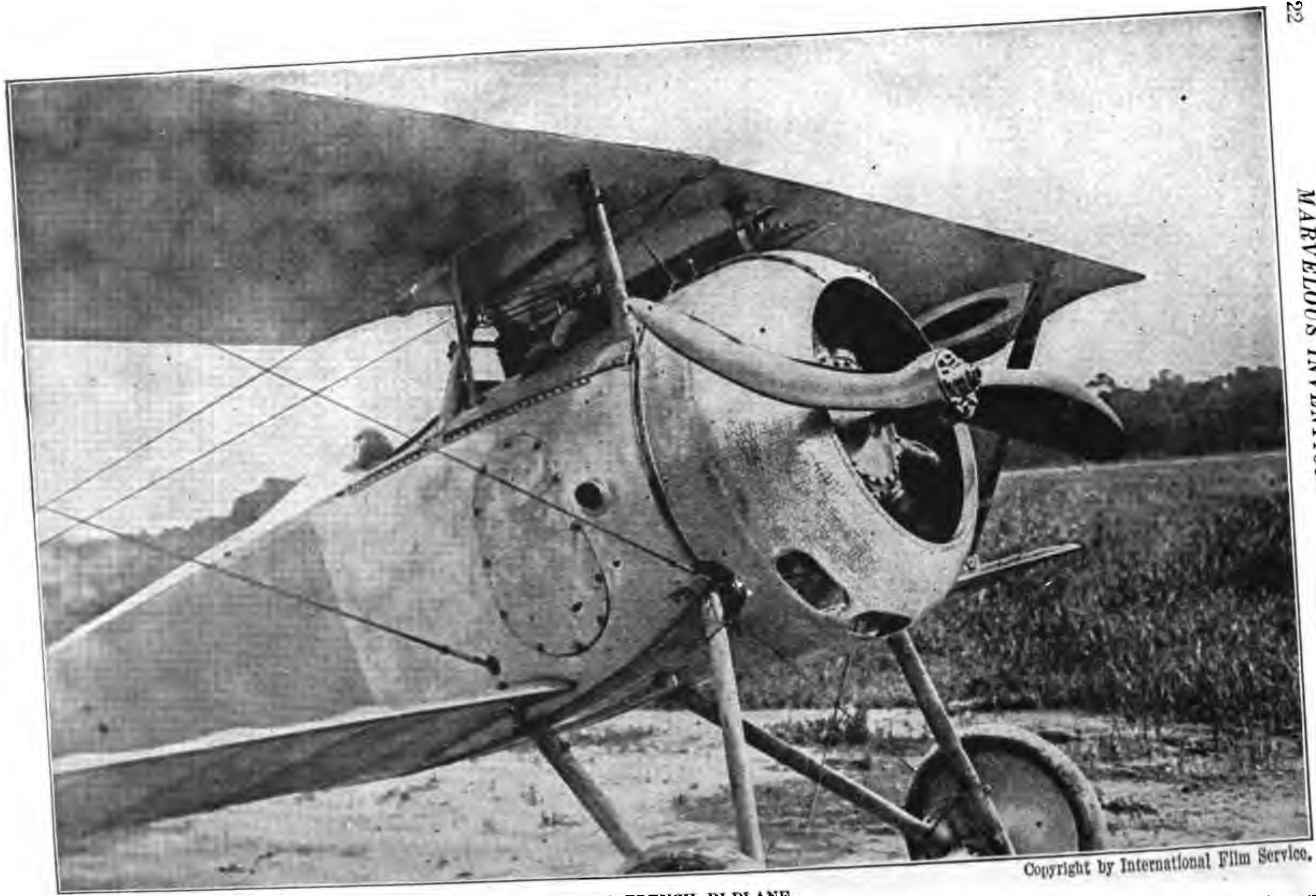
There was intermittent warfare at all times between the soldiers in the front line trenches of the opposing forces. They were shooting back and forth at each other, but they also at times shot bombs and torpedoes into the trenches in the opposite lines. Special guns were employed for this purpose. One such gun is known as a minnewerfer. It could throw grenades and hand bombs from one front line trench to the opposite one. The trench mortar for shooting trench torpedoes was another gun of the same general pattern. These details tend to show the vast difference between modern warfare and wars in former years. Human activities do not remain stationary; they advance—for good or ill—with advancing intelligence.

THE HAND GRENADE THROWERS.

The hand grenade throwers represent a new type of soldier evolved to meet the needs of trench warfare. The soldiers were protected by breast plates, shields, and steel helmets, they fought with hand grenades. All these details are instances of revivals of ancient modes of warfare for modern use. The fighting place for a bombing squad was "No-Man's Land," the space between opposing lines of trenches. The object was to make life in the opposite line of trenches miserable, to do as much damage to the trench as possible and to kill and capture some of the enemy. By cross-examining captured enemies they may give up cherished secrets. A bombing squad consisted of a corporal and seven privates,—two were grenadiers or throwers; two sharp shooters protected the squad, two carried the grenades, and one extra grenadier, served in an emergency in any capacity. These men were all highly trained for the work they had to do. It required as much practice to throw a grenade with precision and force as to make a successful baseball pitcher.

MOVING FORTS TO LEAD THE WAY.

Tanks constituted one of the most novel and most effective of the new weapons of warfare developed by modern science. The problem was to invent some weapon by which the massive lines of trenches defended by the maze of wire entanglements could be overcome. The solution hit upon was the tanks. As in the case of battle ships and guns, tanks speedily developed into two types. The first was the large, massive, slow but very sure-going battle tanks. (Shown in our illustration.) These monsters formed the cruisers and dreadnaughts of the land. Tanks of this kind were first used in the battle of the Somme (1916), and proved their great efficiency in the battle of Cambria (1917). In that battle, for the first time, modern trench lines were broken through. We are to notice that tanks are a further development of the armored automobile; made massive, heavily armored, and given a caterpillar drive. One represented is properly designated as a fortress on wheels.



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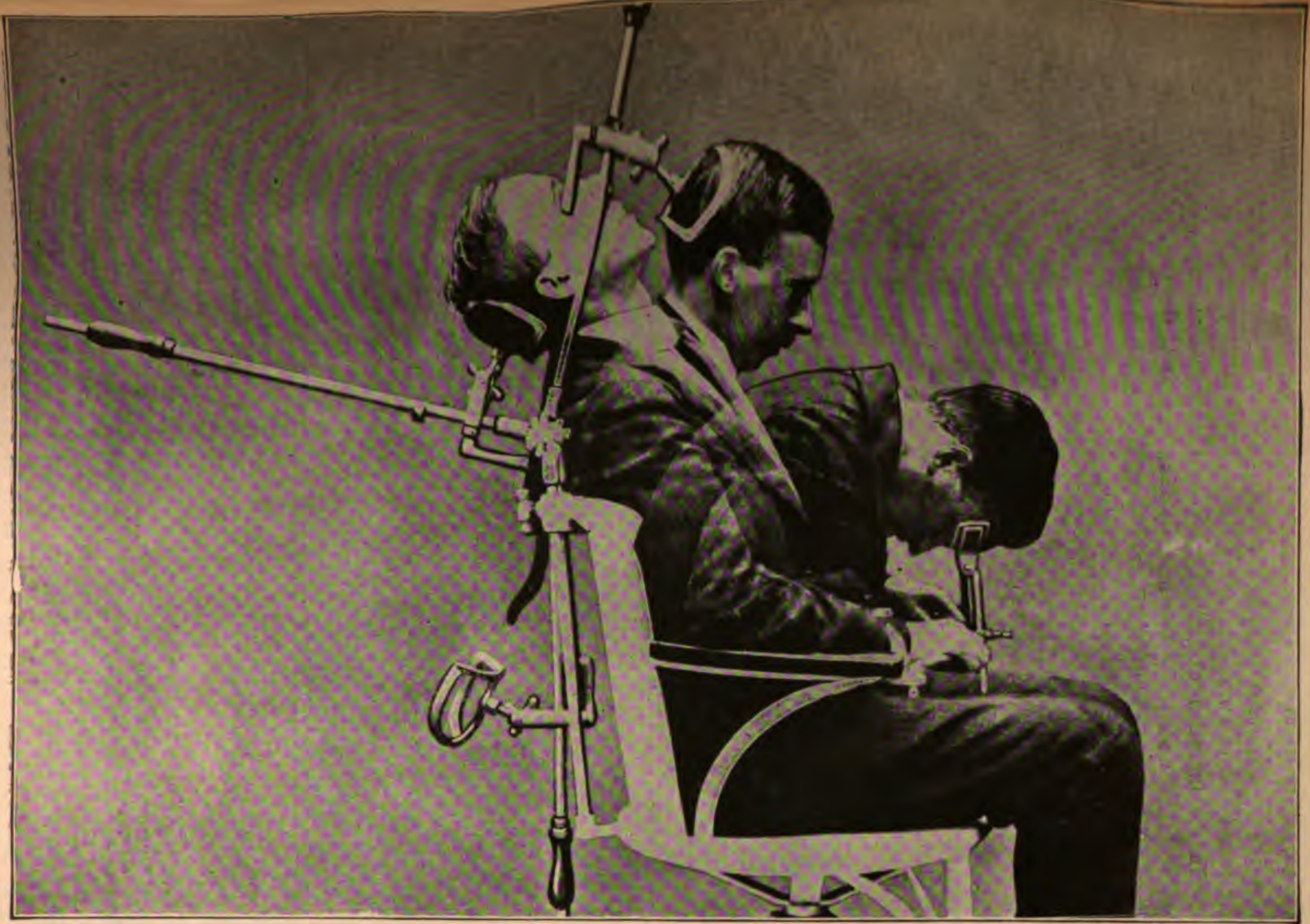
THE FRENCH BI-PLANE.

There are three principal types of air machines used for army purposes. This French battle plane can make about 180 miles per hour. Notice the machine gun on the top. Some battle planes carry two machine guns, one arranged to shoot backwards. Some shoot right through the wings of the propeller (notice the propeller in front), which are revolving very fast, but by a wonderful arrangement the shots are so timed that they do not hit the propeller blades. Battle planes often take an active part in battle flying low down and shelling the enemy. Duels between rival planes are sometimes fought at a height of three or four miles in the air.



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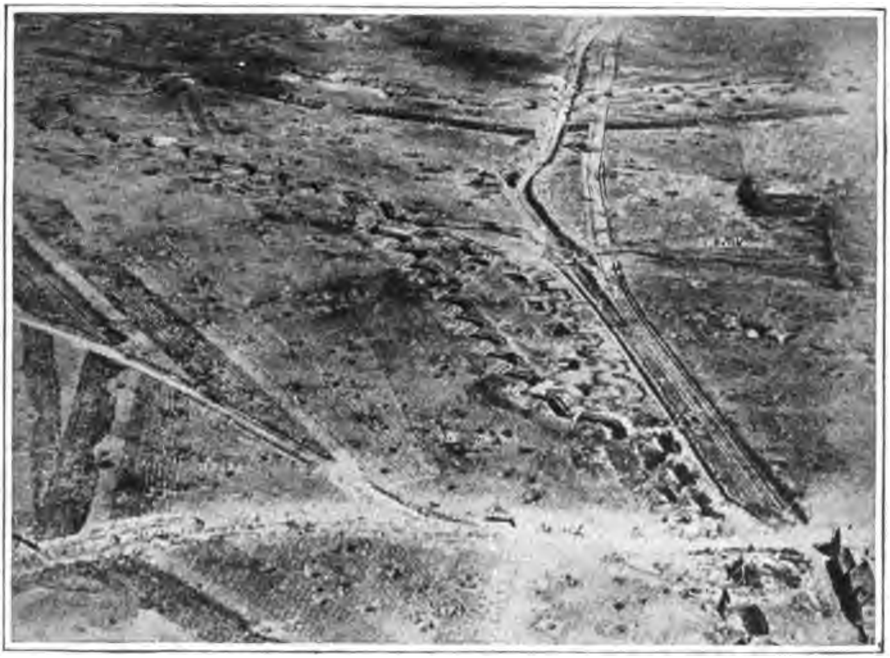
AVIATOR TESTED IN REVOLVING CHAIR.

Out of every 100 men enlisting for air service, only one develops staying qualities. This man is being tested for his sense of balance or equilibrium. The chair is constructed for such a purpose. To test for vertigo, his head is drawn forward and placed on the knee brace, the chair is revolved several times, rapidly, and then suddenly stopped. To test his sense of direction, his eyes are blinded, his head thrown back and after several revolutions, he is asked to stretch out his hand and touch that of his examiner. There are other tests in the upright position.

LIGHT, SWIFTLY MOVING TANKS.

Attention has been called to the revival of ancient armor and customs for modern purposes. In the invention of the light, swifty-moving tanks, manned by two men, we are faced with the strangest of all revivals. It is the twentieth century revival of the armored knight of the days of Chivalry, mounted on his faithful horse, attended by his esquire. The armored horse is the swiftly moving tank, the knight is the gunner, protected in the tank with his revolving turret and his machine gun: the esquire is the driver of the tank. The picture is complete, but this modern knight could rout a whole army of knights of the days when "Knighthood was in Flower."

These light tanks made their appearance in 1918, they were known as the British Whippits and the French Renault tanks. They were manned by two men and could make a speed of twelve miles an hour. They proved themselves of immense service in the closing months of the war. They could go through barbed wire entanglements with ease, clean out machine gun nests and when the retreat began they acted as cavalry and charged with full speed after retreating enemy, breaking up his transportation lines. The use of the tanks, both large and small, solved the problem of trench warfare. Notice again how true it is that new means of defense are met by new means of offense.



A PHOTOGRAPH TAKEN FROM AN AIRPLANE.

A view of a section of the Hindenburg Line. The picture gives many details of trench lines that, when closely examined by experts, reveal much of value as to connecting lines, wire entanglements, etc.

SOLDIERS OF THE SKIES.

Flying being the latest scientific accomplishment of man was of course at once applied to military purposes. But no one dreamed of the great development of flying under the spur of war necessities, or of the many important services flying was to render in the advance of military ends. As the war approached its end success or failure more and more depended on the work of airplanes. They were rapidly growing in importance. Not a few think they were rapidly becoming a deciding factor. Every belligerent nation was making stenuous exertions to increase its air power. The rapidly growing figures of American productions were a great factor in the collapse of Germany.

AIR SCOUTS OF MODERN TIMES.

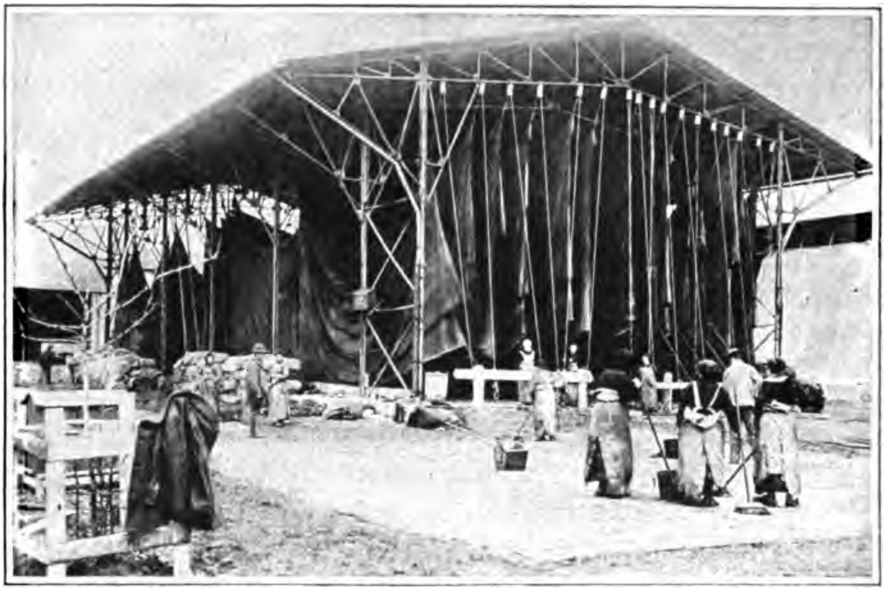
As developed for war purposes, airplanes fell into three principal classes that differed in speed, in fighting strength, and in weight-carrying power; and each class served most effectively different purposes. The light machines that could fly swiftly and could climb rapidly become, in a special sense, the eyes of the army. They were engaged in scouting, reconnoitering, and observation work; by signals, they directed the fire of artillery. Others of this class, armed with the camera were constantly engaged in taking photographs of the enemies positions. It is impossible to over-state the importance of the work of this type of planes. Modern warfare cannot be successfully carried on without such aid. The army whose light-scouting planes are driven from the skies is blinded. This was the first war in history in which the photographic camera rendered effective aid. Observation planes were constantly taking photographs of enemy positions. Any changes in the trench system, in movement of troops, or in the position of batteries was at once apparent from a study of photographic plates. Such photographs, taken at various heights, were developed a few minutes after the air man reached home, flashed on stereoptican screens and "read" by experts, facts learned and sent at once to headquarters.

MADE CAMOUFLAGING A NECESSITY.

To guard against this ability of scouting airplanes and the camera to uncover their movements and bring on the new locations of troops, new trenches, and batteries a withering fire from the enemy, an entirely new art was called into being. The art of camouflaging. Nature has been camouflaging her animals for ages, that is giving them such colored feathers and fur that they will not be readily noticed at a distance, as the polar bear in his dress of white seen against Arctic snow. In camouflaging, the artist is called upon to so paint ships, tanks, large guns, etc., that the airman a mile or so in the air would not notice them. A battery in position, or roads along which troops had to pass, were camouflaged by means of painting strips of matting stretched across it suspended on poles so that the air man would not notice the passing troops. Our government maintained a huge camouflaging plant where thousands of yards of this material was prepared daily. In the navy, vessels were subjected to what is called "dazzle" painting that is painted in such a grotesque manner that a submarine gaining a glimpse through his periscope could with difficulty determine whether the ship was coming or going or in what direction it was moving. Thus art as well as science serves in modern war.

CRUISERS OF THE AIR.

Observation planes formed but one division of airplanes used in war. Battle planes were the fighters, armed with one or



A CAMOUFLAGING PLANT.

French peasant women are engaged in painting rolls of matting. Under cover in the rear long strips of such painted matting is hung up for drying.

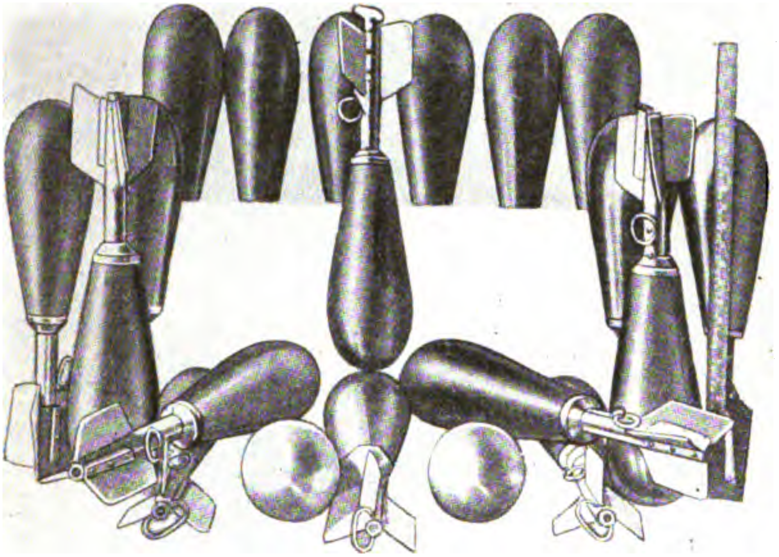
more machine gun. In the first stage of the war it was then their duty to protect the observation plane by driving off the enemy plane. But for the last year of the war, every passing month saw an increasing use of battle planes as a wonderfully effective arm of the service in direct assault. Armed with machine guns and bombs of various kinds they would fly low over the battle field and open up direct attack on massed infantry, or retreating columns, and on transport lines. In some of the later battles of the war the work of battle planes was remarkably effective. Charging columns were dispersed and lines thrown into confusion. The question is if in future wars the battles will not be transferred to the air.

SLOWER MOVING AIR DREADNAUGHTS.

The third division of airplanes was the large, heavy bombing planes of great lifting power, but not swift in flight. They carried bombs. Protected by battle planes it was their duty to fly back of the enemy lines and bomb ammunition dumps, railroad concentration points, machine shops, arsenals, etc., the branch of the work was steadily becoming more effective when the war ended. It is estimated that the systematic bombing of manufacturing cities over a belt of a hundred miles along the Rhine in the fall of 1918, had a great deal to do in the sudden collapse of German resistance. The subtle thing known as the morale of the enemies forces was broken down.

AERIAL BOMBARDMENTS.

On bombing expeditions a regular fleet of airships took part. In October, 1918, 350 American machines made one of most successful bombing attacks of the war. They dropped 32 tons of bombs, loaded with explosives, on enemy dumps and cantonments north of Verdun. Aerial bombs are specially prepared, of various shapes, weighing from 100 to 600 pounds, generally more or less torpedo shaped, provided with tail fins to keep them in position. They are exploded by either impact or by time fumes. The planes were fitted by special dropping mechanisim. The operator was carefully trained since it is a trade in itself to drop a bomb from an airplane a mile or so from the ground, moving at the rate of 150 feet a second and have it land on or near a desired target.



Bombs dropped from airplanes developed to meet changing conditions of warfare. Those used near the close were far more efficient that at first. Scientific instruments of precision for dropping them from a rapidly moving plane were invented.

TRAGIC NATURE OF BATTLES IN THE AIR.

From what we have learned as to the importance of airplanes in war we can understand what efforts were made to gain air control, to defeat, to destroy, drive back the enemies air forces. This was a stage of conflict not anticipated at first but it grew rapidly in importance. Victory in the air was almost as essential as victory on the ground. And so we come to a most thrilling chapter of history,—battles in the air. When two planes met in conflict, perhaps while flying several miles high, it meant almost certain death for one of the aviators. No more striking deeds of heroism were ever recorded than those daily enacted along the extended fronts of the war. There was apparently no hesitation unless one plane was hopelessly outclassed. Thousands such dire battles were fought, thousands of brave men met death in discharge of their duties. To friend and foe alike is due this meed of praise.

TRAINING OF AVIATORS.

When we consider the foregoing, we can but note the steadily growing importance of the airplane in war. Its value as a scout-

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A CAMEL TRAIN IN PALESTINE.

Camels are indispensable in the desert. This view represents a camel train returning from watering. Having taken their fill of water these useful "ships of the desert" are now able to go for several days without further supplies. Thousands of camels were employed by Gen. Allenby in his Palestine Campaign, it is certain he could not have achieved the brilliant success he did without their aid.

ing force was recognized at the start, but no one dreamed of the vast developments of that arm of the service, or of its great potential value as a fighter and a bomber. It has proved its value as one of the most effective arms of the military power. Considering the fact that airplanes are highly scientific machines, very expensive to build and to equip, and finally the great value of their service, we can understand the necessity for great care in the selection of aviators. To do this effectively, required an expensive educational system vastly more complete than any one dreamed of at first. It was necessary to teach men not only how to fly, but how to send messages by wire, to operate machine guns, to travel hundreds of miles by compass, to drop bombs so as to hit target when moving very swiftly, at a great height. These men when flying would certainly sooner or later be confronted with situations that required instant decisions, iron nerves, and ability to see and do the one necessary thing for safety. Only men with exceptional mental and physical capabilities could be taken. They had to be tested in a rigorous physical examination. It was found that some men perfectly capable of flying, say 8,000 feet high, were utterly unfitted for flight at a height of over 20,000 or more feet, so that they had to be graded or assigned to work in planes intended for different classes of service.

GASOLINE IN WAR.

We have called attention to the importance of several substances not usually considered in warfare, but modern warfare by new methods has made them serve most important ends. Among these substances are cotton, barbed wire, and the camera. There are some students that think gasoline (called in Europe petrol) is more important than any to which attention has been called. Without gasoline there could be no flying machines, no tanks, no submarines, and no auto trucks, and how can modern war be carried on without such accessories? It never was of importance in former wars. In the use of gasoline, then, we have a striking instance of a substance never before considered as a factor in warfare made to serve a number of absolutely essential ends in modern war.

THE MOTOR TRUCK IN WAR.

There were of course thousands of horses and mules employed in the army, and in Mesopotamia and Syria thousands of camels. But the great transporting agent after all, especially on the Western front was the auto truck. Lord Curzon of England has publicly stated that the war could not have been won without the use of trucks. General Pershing had at his call 50,000 trucks; it is difficult to see how his movements could have been carried out without their help. His immense supplies of all kinds were, in places, moved only by their help. It was not unusual in the last year of the war for 10,000 motor trucks to be assembled for one purpose, such as moving an army corp to a new section of the line. There is one instance of 30,000 trucks being moved as one unit. The first battle of the Marne was only won by General Joffre commandeering every auto vehicle in Paris and so transporting General Manoury's army to the scene of the battle with Von Kluck. Verdun with railroad communications severed was saved by the ceaseless trains of trucks bringing supplies. Our marines were hurried by trucks to Chateau-Thierry where they arrived just in time to check the onward rush of enemy troops on Paris.

A MOTOR TRUCK TRAIN.

DOGS OF WAR.

Dogs were used in large numbers on the Western front and their deeds are worthy of record. Some dogs were actually decorated for their great services. During the last days of the great war the French Army had 10,000 dogs in its service. The intelligence they displayed was most remarkable, being readily trained to perform all sorts of services. They might not have known the dangerour nature of their work; but the mere fact that they endured hunger and cold, and worked incessantly day and night is entitled to mention. They were busy in carrying food and ammunition to the first line trenches, also medical supplies to the wounded lying on the field. They could find the wounded in deserted trenches and in shell holes. When they found such a soldier they carried a cap or belt or something back as a guarantee to searchers that they had found one needing help, and they were eager to lead such helpers back. They were busy doing sentinel duty in no-man's land. They were employed to guard prisoners, and they knew very well the difference between the German prisoners and the French soldiers.

As dispatch carriers, dogs were of the greatest value. These faithful allies passed barrages and areas under machine gun fire where no soldier could have gone, and they knew how to crouch as low to the ground as possible in sections exposed to enemy's fire. They might die, but they knew nothing about giving up the attempt or surrendering. Even in gas-soaked territory dog couriers were used, being fitted with special gas masks for that purpose.

QUESTIONS ON MODERN WARFARE.

What is meant by radius of action of a submarine?

What submarine visited Baltimore?

What is meant when a submarine is running awash?

Explain about the periscope?

What is a submarine torpedo?

How did we defend against submarine attacks?

How large are torpedo destroyers?

What are depth bombs?

What is the difference between a dreadnaught and a cruiser?

Describe a navy 16-inch gun—weight of shell, distance thrown, height in air.

How far apart were rival ships in the battle of Jutland?

Describe submarine mines?

With what explosives were they filled?

Describe the great mine barrage near Norway?

What are mine sweepers?

How is smokeless powder made?

In our illustrations we have a cannon and a ship of one hundred years ago. Mention some points in which they differ from cannons and ships today.

What are high explosives?

What is T. N. T?

What are shells? What are the size and weight of some?

What are gas shells?

What are star shells?

What are gas masks?

What are anti-aircraft guns?

How was barbed wire used in the war?

Describe how our navy 14-inch guns were used?

Describe machine guns?

Is an observation balloon an airship?

What is meant by a flame throwing attack?

What can you say about the extent of a modern battle front?

Describe trench warfare?

What is a periscope rifle?

What are trench bombs and torpedoes?

Describe grenade throwers?

Describe tanks?

In what battle were they first used?

In what way do the light tanks remind you of the Age of Chivalry?

Describe the use of flying machines in war?

How did the camera help in war?

What is camouflaging? Why was it necessary?

What are the three kinds of airplanes used in war, and how do they differ?

How were air pilots tested?

In what way was gasoline of importance in war?

Use of motor trucks in war?

Use of dogs in war?

The Battle of Gettysburg was somewhat similar to the Battle of the Marne.—Now compare them as to number of men engaged, extent of battle front, number and kinds of guns? What means did General Joffre have of knowing how the battle was going that General Mead did not have? Any tanks used in the Marne? Was that a battle in the open or trench warfare?

We have studied electricity and flying machines. Which was of greater service in winning the war? Give your reasons.

THE GREAT INVENTIVE AGE

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THOS. A. EDISON.

Everybody is looking today toward East Orange, N. J., where America's great old "Wizard," Thos. A. Edison, is working in seclusion 16 to 20 hours daily to invent something effective against the submarines. Picture was taken very recently and is the only one ever made of Edison showing the great inventor working in his laboratory.

The American people are justly celebrated for their inventive talents. The submarine and the flying machine are among our recent triumphs. The former effected a revolution in naval warfare; the latter not only profoundly influenced war on the land, but it is destined to change the entire texture of business and social life; no nation in the world has made so many inventions, of minor importance in themselves, but which, when considered in a mass, are found to contribute in countless ways to the well being of society. We have considered the many ways in which electricity is made to serve us. This has only been possible by reason of hundreds of inventions, the majority of which were the results of American inventive ingenuity.

It will be inspiring to consider the general field of invention in which mankind has been active in recent decades. We have but just passed a critical point in human advance. For some years the energies of the principal nations were devoted to war. We now enjoy the blessings of peace. It is reasonable to expect many inventions in the near future—some doubtless of great moment, perhaps of a revolutionary nature, for many of nature's closely guarded secrets seem outlining before us. Not considering inventions of that nature many of lesser importance but contributing to the happiness of life may be confidently expected. So let us pass in review some of the inventions of recent years and notice their bearings.

THE AUTOMOBILE

THE MODERN AUTOMOBILE.

No invention of the last quarter century has worked greater changes in social life than the automobile, which has now been brought "within the reach of all," with the wonderful development of the small, inexpensive car and the gradual reduction of operating expense. To-day the automobile, not long ago a rich man's luxury, is found by thousands on the farm, in the village, and in the back yard garage of the salaried city man and the wage-earner. In the brief space of two decades the auto has developed from a mere experiment to the product of one of our largest industries. It has caused the construction of thousands of miles of improved highways, has almost abolished the horse in the cities, has changed to a marked extent the manner of living of an appreciable portion of our people, and has directly induced extensive and radical improvements in, and created dozens of, collateral arts and manufactures. The modern automobile is the result of a series of engineering development continued during a whole century of persistent effort to provide a practical self-propelled car. Its complete success, however, dates from the advent of the Daimler gasoline motor, the distinctive features of which were lightness and speed. These were precisely the features required to insure the success of a self-propelled vehicle and the world stood ready to welcome the new means of locomotion with open arms and a rush for its adoption. The new gasoline engine was peculiarly adapted for its specially designed purpose, and as one authority says, "The improved engine designed in 1889 by Daimler was that which really set going the motor-car movement." In that year Daimler's patent rights were acquired by two Frenchmen, Panhard and Levassor, who devised the first motor carriage along present lines, and may be said to be the creators of the automobile industry.

OFF FOR A PLEASURE JAUNT.

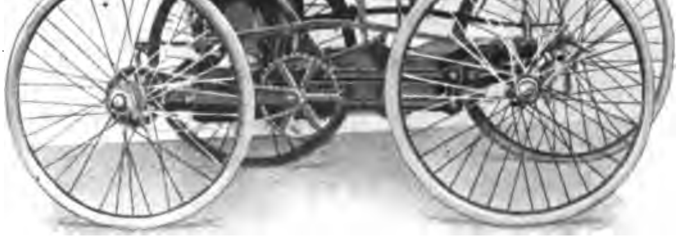
In the United States the manufacture of automobiles has reached phenomenal proportions, constituting one of the marvels of industrial history. The annual output is valued at something like a half billion dollars, and the industry is responsible for a tremendous growth in population of the motor-car manufacturing centers. Exports of automobiles from the United States in the fiscal year ending June 30th, 1918, including shipments to Alaska, Hawaii and Porto Rico, amounted to $74,423,357.

AMERICA'S FIRST CAR.

Elwood Haynes is generally recognized as the inventor and builder of America's first automobile, which made its initial trip at Kokomo, Indiana, on July 4, 1894. This original "horseless carriage" is now an object of much interest among the other "relics" in the Smithsonian Institution at Washington, D. C., showing the great advance since made.

The crude carriage that was a curiosity less than twenty-five years ago—the vehicle that "vied with the two-headed calf and the wild man of Borneo at the county fairs"—was the forerunner of one of the greatest aids to transportation invented since the dawn of civilization.

Mr. Haynes' idea of making a gasoline-driven car was an inspiration of his inventive genius. In the summer of 1893 he began the actual construction of a machine, using



THE PIONEER AMERICAN CAR.

a one-horse-power marine upright, two-cycle gasoline engine. This little motor gave barely one brake horse-power, but weighed 180 pounds. It is interesting to note, in this connection, that a modern aeroplane motor of the same weight readily gives forty horsepower.

The total weight of the pioneer machine, when completed, was about 820 pounds. It was built up in the form of a small truck, with bicycle tires. On July 4, 1894, when ready for a test, it was hauled into the country behind a horse carriage, and started on a nearly level turnpike. "It moved off at once at a speed of about seven miles per hour, and was driven about one and a half miles farther into the country. It was then turned about, and ran all the way back into Kokomo without making a single stop." One can well imagine the elation of the inventor at this initial success; but even he, while realizing that there was a future for the "horseless carriage," did not even dream of the marvelous development that has followed.

The best speed attained with the original machine was about eight or nine miles an hour. Nineteen years later the inventor coasted into Columbia, Missouri, at 35 miles an hour, while the racing speed record for automobiles stood in 1915 at well over 100 miles an hour.

One year after the first trial of the pioneer automobile, the first automobile race in America was held in Chicago, and the original car driven by Elwood Haynes participated in the race. From that time on the use of the motor car and its manufacturing industry progressed by leaps and bounds.

A TAXICAB.

The great majority of motor vehicles may be classified under two principal types—those propelled by gasoline engines and those propelled by electric motors supplied with a current from a storage battery.

THE GASOLINE MOTOR.

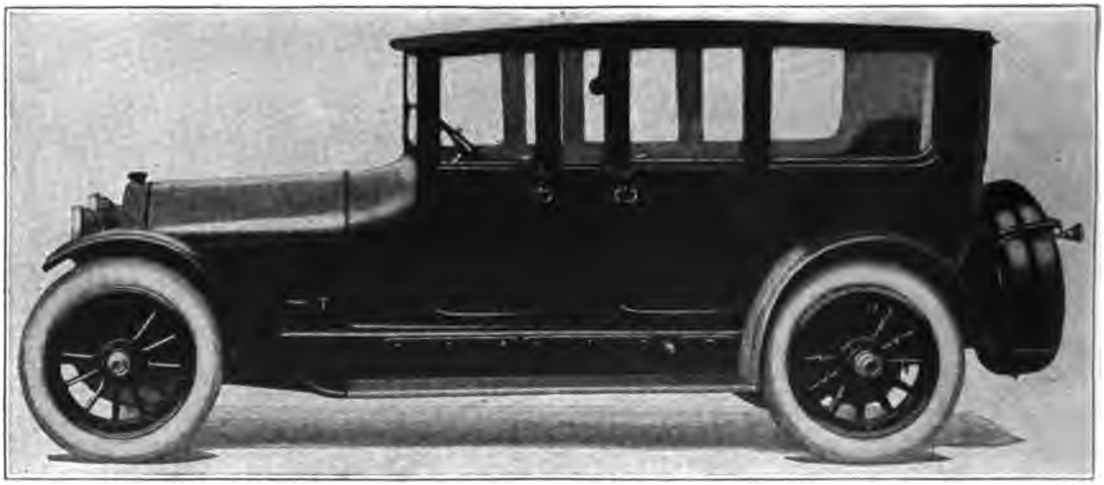
The motor car of to-day resembles the original horseless carriage only in the fact that it is motor driven. There is no longer any mystery about its construction or means of operation. Almost everyone who has ridden in an automobile knows the principle of the gasoline propelled vehicle. A novice may be staggered at first at the sight of the modern control board, on which is located the mastery of every part of the car, but a little study of the operation of the gasoline motor and the transmission mechanism will soon enlighten a car-owner and enable him to drive his car intelligently.

"Internal combustion engine" is the term which perhaps best describes the gasoline engine, or motor with which most automobilists have to do. The principle of operation is based on the well-known facts that gasoline vapor, or a fine spray of gasoline mixed with air, forms a highly inflammable mixture; and that if this mixture be confined in a closed chamber and ignited by a flame or spark it will explode and the gases formed exert expansion power. This is what follows in a gasoline engine, the expansion pressure being used as the motive power.

An internal combustion engine can use various kinds of fuel, but all of them are hydrocarbons. In motor car practice the fuel in most general use is the very light hydrocarbon known as gasoline, or petroleum spirit, called in Europe, petrol. The device by which the gasoline vapor and air are mixed is called a carbureter, from the fact that by its means the air is charged with the hydrocarbon or it is carbureted. At the outset, it is sufficient to know that the gas or mixture is sucked from the carbureter into the engine by the action of the latter.

The engine or motor consists primarily of a cylinder or set of cylinders (from two to twelve), each with a piston and a rod connecting the piston to a crank on a crankshaft. The piston slides up and down in the cylinder as the plunger of a tire-pump slides up and down in its barrel. It operates on the crank through the connecting rod, just as a cyclist turns the crank of his bicycle by his leg from his knee.

The motor has a cycle or series of four operations: 1, suction (intake or induction); 2, compression; 3, firing (ignition, combustion, or explosion); and 4, exhaust. They are performed in each cylinder, in two



Courtesy of Locomobile Co.

ENCLOSED DRIVE LIMOUSINE.

revolutions of the crankshaft, corresponding to two outward or downward strokes and two return or upward strokes of the piston.

Taking the case of a modern typical six-cylinder car as an example—there is a spark plug on each of the six cylinders connected to a distributor or the magneto. If the switch on the dash-board is thrown to the indicator "On," a spark will jump 1-64th of an inch across the points of the spark plug in each cylinder as the piston comes into the firing position.

Let us suppose then that the switch is placed at "On," the gas lever on the steering wheel set one-quarter of the way down the quadrant, and the starter button pressed. The starter of our typical car is a successful application of a small electric motor through gears to the flywheel, which is located at the back of the engine and is fed by a powerful storage battery.

Then as we set the starter lever on the wheel and press down the clutch pedal these gears come into mesh, and revolve the flywheel. The first downward stroke of the piston in the cylinder opens the intake valve and sucks in gasoline vapor from the carbureter; the valve closes at the bottom of this piston stroke, and as the flywheel continues to revolve the crankshaft, to which the pistons are attached, the upward stroke compresses the gas admitted until the height of the stroke is reached, when the spark jumps across the spark plug and ignites the compressed charge. The explosion sends the piston down; at the end of this downward stroke the outlet valve is opened and the flywheel of its own momentum now moves the piston up once again and forces all dead gas out into the muffler pipe, thence to the air. At the top of this latter stroke, the intake valve admits more gas and the entire set of movements begin again.

Courtesy, William Heinrich.

LATEST CONVERTIBLE SEDAN, CLOSED.

Thus we see that two complete revolutions are necessary to fire a cylinder in our typical engine, each being set to fire once every second stroke. It is easily understood that three cylinders fire every time the flywheel revolves once. The flywheel is revolved by the impulse of the cylinders, but is of such weight as to transform the intermittent jerks into one continuous stream of power.

Such an engine is called a 4-cycle motor because four distinct actions are necessary to fire each cylinder once.

Some time after the invention of the 4-cycle gasoline engine, a 2-cycle motor was produced. This has met with considerable success, but has been more used in motorboat engines than in automobile practice. In this type of engine there is an explosion at every revolution of the crankshaft. The crankshaft is inclosed and the operation is as follows: When the piston moves away from the crankshaft a partial vacuum is created in the crankcase, thus causing a mixture of gas and air to enter from the carbureter attached to the crankcase. When the piston again moves towards the crankcase, this mixture is compressed and passed through small channels extending upward and leading into the cylinder just above the top of the piston. These entrances into the firing chamber are called ports. The gas being forced through them into the cylinder, the piston moves outward from the crankshaft and compresses this mixture, which is then ignited, forcing the piston again toward the crankshaft. Just before reaching the point nearest the crankshaft, the piston uncovers a small slot, leading the exhaust outward into the muffler and thence to the air. Immediately afterward it uncovers another slot, which admits a fresh supply of gas and air from the crankcase, which drives out the burned gases still remaining in the cylinder. The piston now returns to its initial position and the same operation is repeated. This motor, it will be noted, makes one explosion for each revolution of the flywheel, necessitating only two motions —a downward and an upward stroke of the piston. For this reason it is named a 2-cycle motor.

OTHER MECHANISM OF A MOTOR CAR.

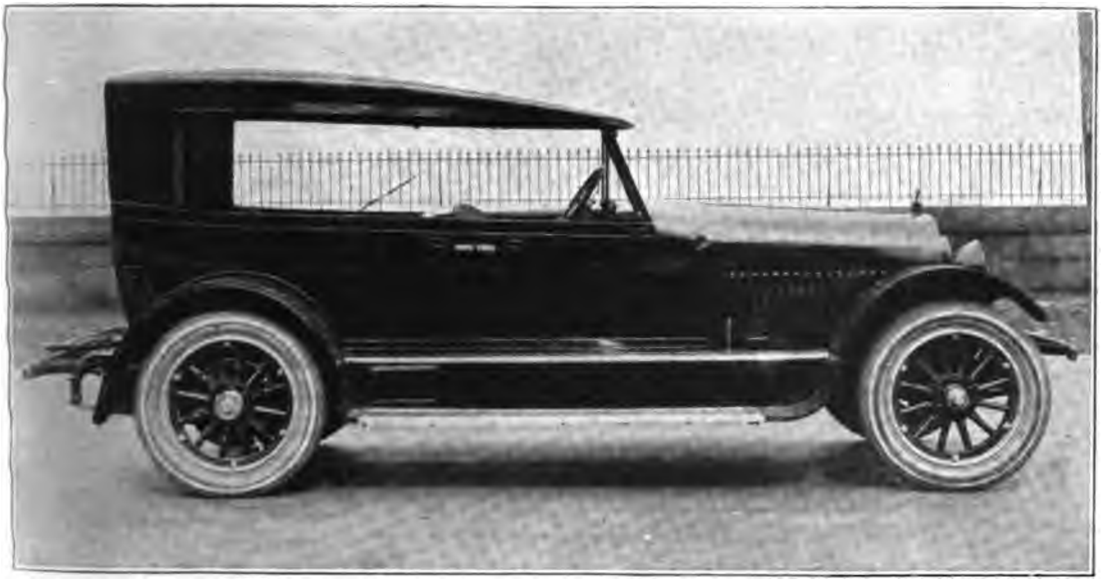
In our typical modern automobile the gasoline motor proper is only a part of the mechanism needed for successful running. In addition to six cylinders firing every two revolutions a minute (1,200 motor explosions a minute), a great many other operations are going on under the engine hood, each of which is vitally necessary to the perfect operation of the motor; each performs its duty silently but faithfully.

First of all there is a magneto, a small electric generator that furnishes current to the spark plug at the rate of 1,200 sparks a minute. Then there is a powerful electric generator that sends 5 to 13 amperes of 12-volt current back to a battery of 60 amperes capacity, which will store it away until it is needed for either starting or lighting. There is a camshaft, revolving at one-half engine speed, which is opening the intake and exhaust valves with every move of the piston. There is a centrifugal pump that circulates the hot water from around the cylinders into the radiator, where it is cooled by a revolving fan, and sends cool water back to the cylinder jackets to cool the walls and pistons heated by the rapid explosions.

There is also a complete oiling system constantly pumping fresh oil to the bearings which support the crankshaft and to those which attach the rods connecting that shaft to the pistons. The various types of oiling systems include the gravity feed, the splash feed, and the forced feed.

TRANSMISSION MECHANISM.

The power of the motor is transmitted to the driving mechanism of the automobile by means of a clutch, which is thrown into or out of engagement with the flywheel by a foot pedal operated by the driver. The power is delivered through the clutch to the speed gears and thence to the rear axle. In order to drive the car at different speeds, and at the same time exert the full power of the motor at these different speeds, it is necessary to have two or three ratios between the motor and the rear axle. The modern car is generally equipped with three speeds forward, and one speed reverse, by means of two shafts arranged to rotate in an inclosed gear box made of aluminum. Each of these shafts is supplied with a set of gears of different diameters, representing the different speed ratios. In the latest improved cars the speed gears are shifted by electricity.



Courtesy, William Heinrich.

LATEST CONVERTABLE SEDAN, OPEN.

Every year sees some new devise that adds to the efficiency of the automobile, and it is becoming more and more a necessity in modern life. It is transforming rural life, giving it more of richness and pleasure. It is a great stimulus to the good roads movement. Any and all means that thus improve living conditions in rural sections is a great blessing to our country for the welfare and happiness of our land depend on the welfare of the rural communities. Thus it is that all improvements in automobiles have an influence on our entire country and on all industries.

From the speed gears the power passes to the rear axle through a jointed steel shaft having a universal joint at the point where it joins the transmission and also where it joins the rear axle. Within the rear axle are located both a small and a large bevel gear. The former is keyed to the end of the driving shaft while the latter serves as a driver for the rear wheels. These wheels run concentric with the rear axle shaft; they are not connected with each other, but are each in turn of concentric gears within the rear axle. This is necessary in order that the automobile may turn corners, inasmuch as one wheel must practically stop, while the driving or power impulse must come from the wheel which meets the least road resistance. The latest models have what is called a "full-floating rear axle," the joints and shafts being loosely connected.

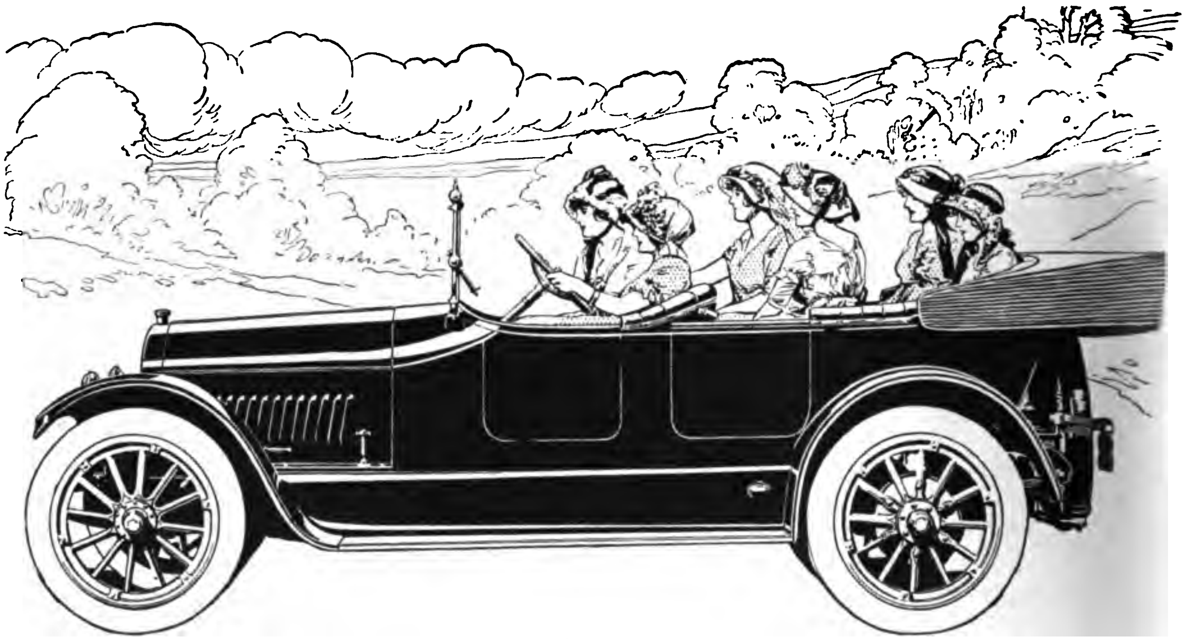
The wheels and brake drums being connected to each other and revolving upon the axle casing in which the driving shaft runs, are supported by roller bearings to insure minimum friction.

Each movement of the modern car is directed by a perfectly working mechanical device controlled from the left front or driver's seat.

THE EIGHT-CYLINDER CAR.

In the season of 1915 the 8-cylinder car proved an absorbing topic for automobile engineers and experts, as well as for the layman, and many 8-cylinder cars were speedily rushed upon the market. The engine proved to be of unprecedented flexibility and secured remarkable smoothness of riding.

The engine itself is very compact and does not require an unusually long space for its installation. There are two blocks of four cylinders each, mounted on the crankcase at an angle of 90 degrees to each other. In firing there is a power impulse from a cylinder on one side, followed by an impulse from one on the opposite side, the firing alternating, first on one side and then on the other. This gives eight impulses during each complete cycle (of two revolutions), one impulse every quarter-turn of the flywheel. The advantage being that there is no intermission between impulses. The torque is constant and the flow of power continuous. The result is an engine practically free from vibration, whether running at high or low speeds.



AN 8-CYLINDER CAR.

THE TWELVE-CYLINDER CAR.

In 1908, George Schebler of Indianapolis, inventor of the carbureter which bears his name, built a 12-cylinder car. It was a special car and regarded more as a curiosity than anything else. Up to 1915 it had covered a distance of 30,000 miles. It could be run on either twelve or six cylinders. This was made possible by the use of two carbureters, each feeding to six cylinders. When highways were smooth and travel easy, only six cylinders were used to propel the car, but in rough going all twelve were employed.

In 1913 an English Sunbeam car was built for high speed work on racing tracks. It was designed and built by Louis Coatalen, a builder of high speed machines, expressly to break the world's record of 106 miles an hour. In this he was successful, making a record of 107 miles an hour. In 1914 this machine broke its own record and was run at the rate of 108 miles an hour. Up to 1915 these two cars were the only specimen of 12-cylinder cars, and both were built for special purposes.

With the coming of the eight cylinder car it seemed as if the end had been reached in the manufacture of multi-cylinder cars, for every day use, but at the national automobile show in 1915, when the eight cylinder cars were for the first time shown the announcement was also made by two prominent manufacturers of an output of twelve cylinder cars intended for every day use, and not for special purposes like the two cars just described. This shows the rapid rate of automobile development, which as far as cylinders is concerned, had gone from six to eight, and then to twelve in one year.

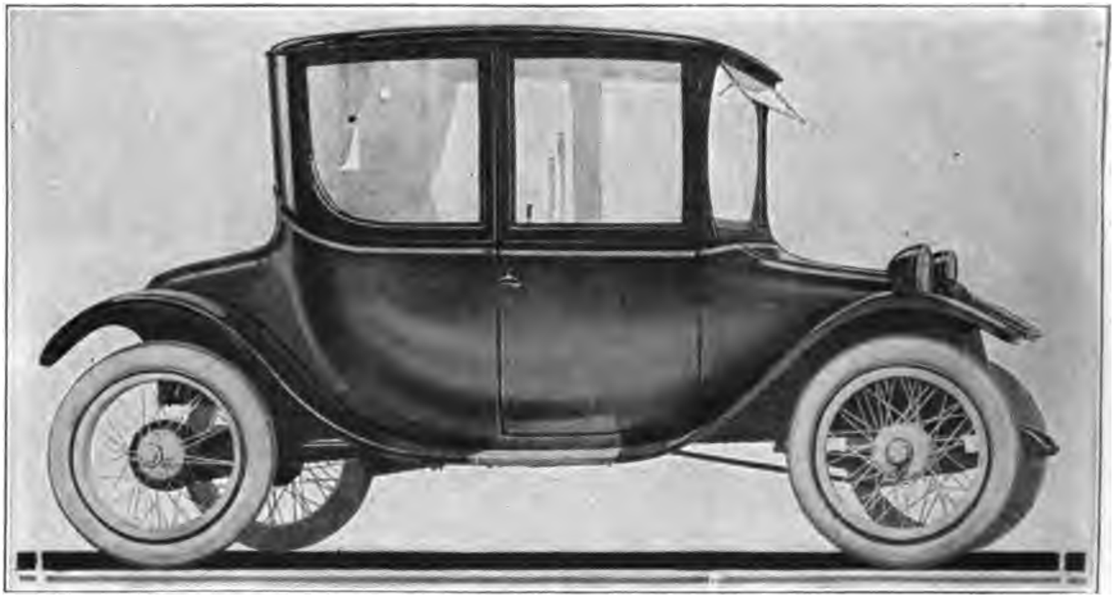
Courtesy, William Heinrich.

LATEST MODEL ROADSTER—TOP FOLDED OUT OF SIGHT.

THE ELECTRIC MOTOR CAR.

The electric motor car is the ideal one in some respects, but is inferior in others. Its chief handicap is in the means of applying energy to the motor. Its superiority is in the means of applying and controlling the energy afforded by the motor.

The continuous torque, perfect balance and high speed of which the motor is capable diminish the stress on the transmission gear or chains and effect an economy of weight by dispensing with flywheels, gears, etc., which, however, is not sufficient to counterbalance the excessive weight required by the storage cells if they are to have any length of life and to travel for distances comparable to the mileage of gasoline cars. Unlike the gasoline engine, the electric motor may be made to turn at a constant speed regardless of the gradient, or at an approximately constant rate of working no matter what speed, within limits. These qualities afford advantages over the explosion engine. The electric is, to a degree which is not always appreciated, simpler than the gasoline car; that is, the ordinary gasoline car frequently carries in miniature the whole of the complication of the electric vehicle with an internal combination engine and a gear-box in addition.



Courtesy, The Milburn Co.

THE MODEL ELECTRIC FOR ALL SEASON SERVICE.

In recent years, for city and suburban use, the electric car has become extremely popular; because of its ease of operation and its cleanliness. It is also largely used by the medical profession. Its low cost of maintenance, cheap librication, and freedom from motor troubles have strongly recommended it to the American public, and the streets and boulevards of all our large cities now bear witness to the development and popularity of the electric vehicle.

In construction the electric motor is practically the same as the familiar dynamo, but as it is used for a different purpose, and often under very different conditions, some changes have to be made to secure efficiency and reliability. By a different arrangement of the armature wiring, a greater power to start from rest under a load can be obtained.

The electric motor is not self-contained like the internal combustion engine, but is equivalent to a steam engine without the boiler, as it only transforms one form of energy into another. The speed can be regulated by the supply of current, and it is almost silent in running. Like the gasoline motor, it can be started at once, and has the further advantage that it is self-starting. As electric motors for traction work have been in use for some years, there is no need for electric motor-car builders to design any special types for the cars, though many improvements have, in fact, been made.

The present-day models of electric pleasure vehicles are generally beautiful in design and luxurious in appointment.

THE MODERN WAY. Courtesy, Sandow Motor Truck Co.

MODERN MOTOR TRUCKS.

When the motor-truck industry was in its infancy, only a few years ago, a close student of economic conditions predicted that before many years the total investment in motor vehicles in the United States would equal the present investment in the railroads of the country.

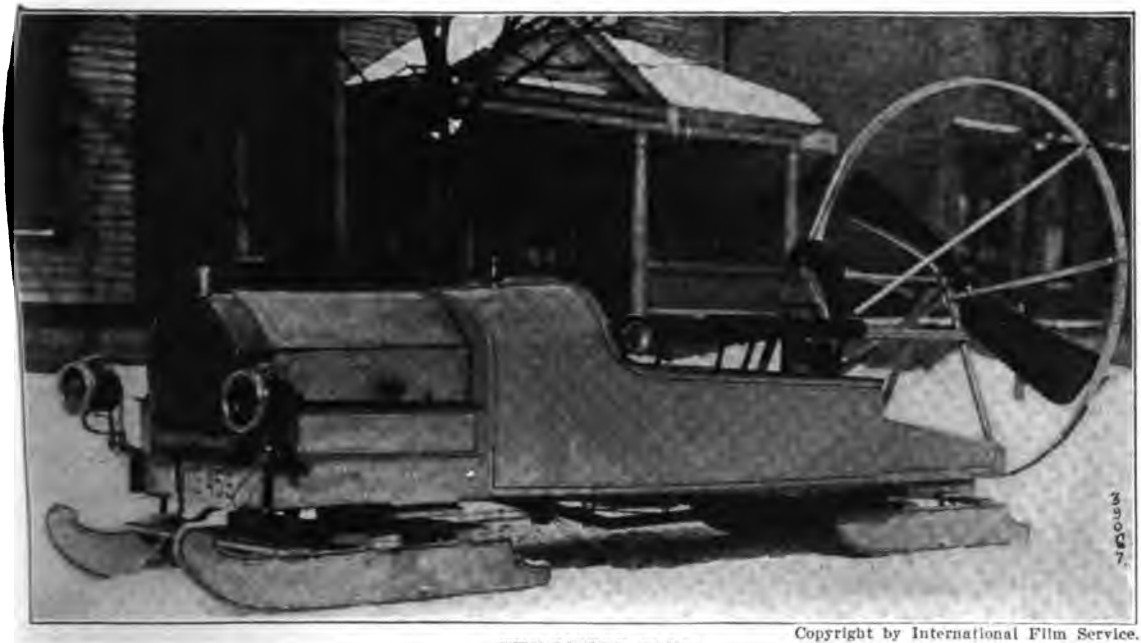
Any industry which gives promise of such gigantic proportions touches the public interest closely. As the pleasure automobile has revolutionized country life, added greatly to the suburban area of cities, and created anew a nation of lovers of out-of-doors, so motor transportation of merchandise is effecting a revolution in the manner and cost of living which affects every individual, even those whom the pleasure car has not yet reached.

In the motor truck we have a new and powerful servant, cheap and efficient. It would be difficult to point out a class of delivery in which some type of motor vehicle cannot be made more profitable than the horse-drawn vehicle. The general efficiency of the motor truck is an admitted fact.

Considering it only from two broad instances of economy contrast the stable that houses a fair-sized equipment of horses and wagons with the garage which would amply shelter the motor trucks that might displace them. Add to this result of a simple subtraction in ground rent the factor of being able to locate the garage at a greater distance from the store or warehouse, with no loss of time or exhaustion of horses—and this one economy assumes tremendous proportions.

There are now on the market motor trucks for almost every conceivable purpose of the retailer, the wholesale merchant and the manufacturer. These range in load capacity from a few hundred pounds to five tons or more. There are vehicles at low cost to replace the single-horse delivery wagon, and giant trucks that make light of loads which would require many horses to handle. The speed of the motor vehicle enables it to make several trips in the time required for a single trip by horse-drawn vehicles. Thus the grocer who has four or five horse wagons can usually replace these with two light motor trucks of a capacity of 500-750 pounds and give better service. The trucks will carry the same total load, give more mileage and be much faster. In order to secure the most satisfactory results, however, the machine must be of exactly the right type for the particular class of work it is called upon to do. The machines now upon the market afford a wide range of choice.

FREIGHT CAR OF THE HIGHWAYS. Courtesy, Sterling Motor Truck Co.



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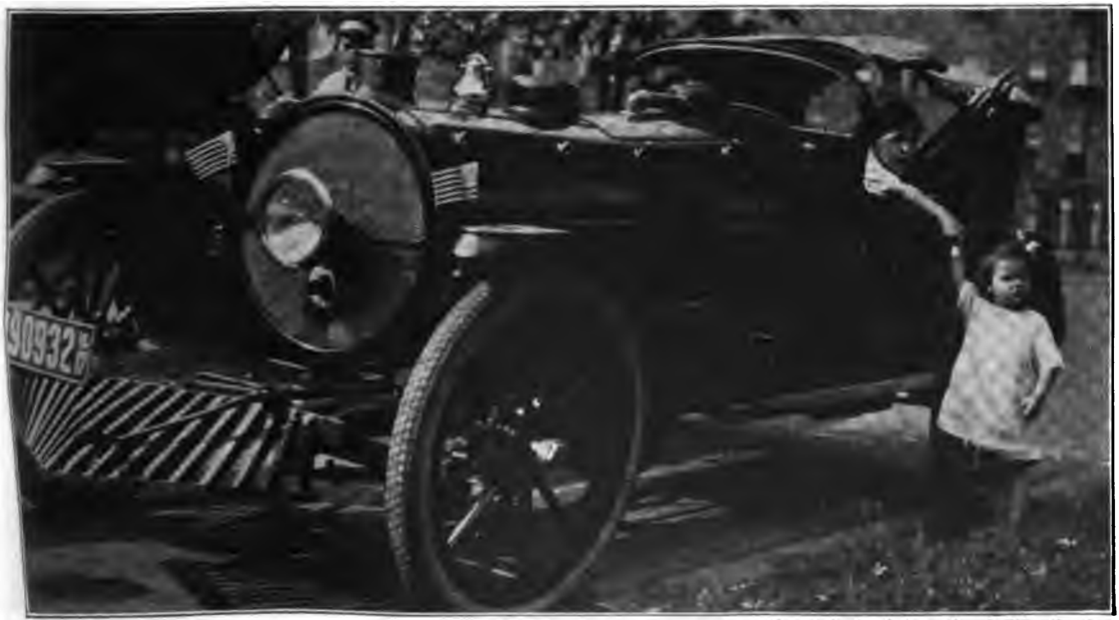
THE MOTOR SLED.

A picturesque and practical combination of a pair of bob sleds, an automobile, and the propeller of a flying machine, the entire outfit being called a motor sled, and is the invention of Nelson Sillinger of Buffalo, N. Y. It develops twenty horse power, and can make eighty miles per hour when the going is good, carrying five passengers.



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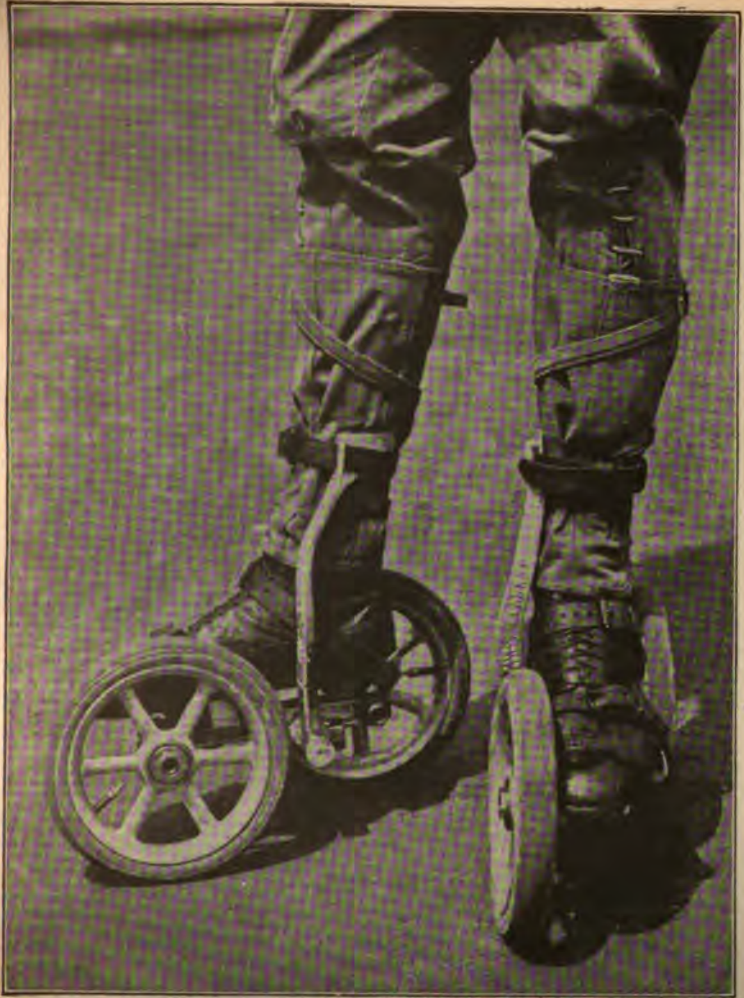
AN AUTOMOBILE LOCOMOTIVE.

This automobile locomotive is capable of drawing a train of loaded wagons or trucks and can make sixty miles per hour. It may help solve the transportation problem. In appearance it is a locomotive, but power is supplied on the automobile principle. It is air controlled, has an air whistle, and is furnished with a bell. It is built of steel and aluminum The invention of A. F. Steward, of Chicago.



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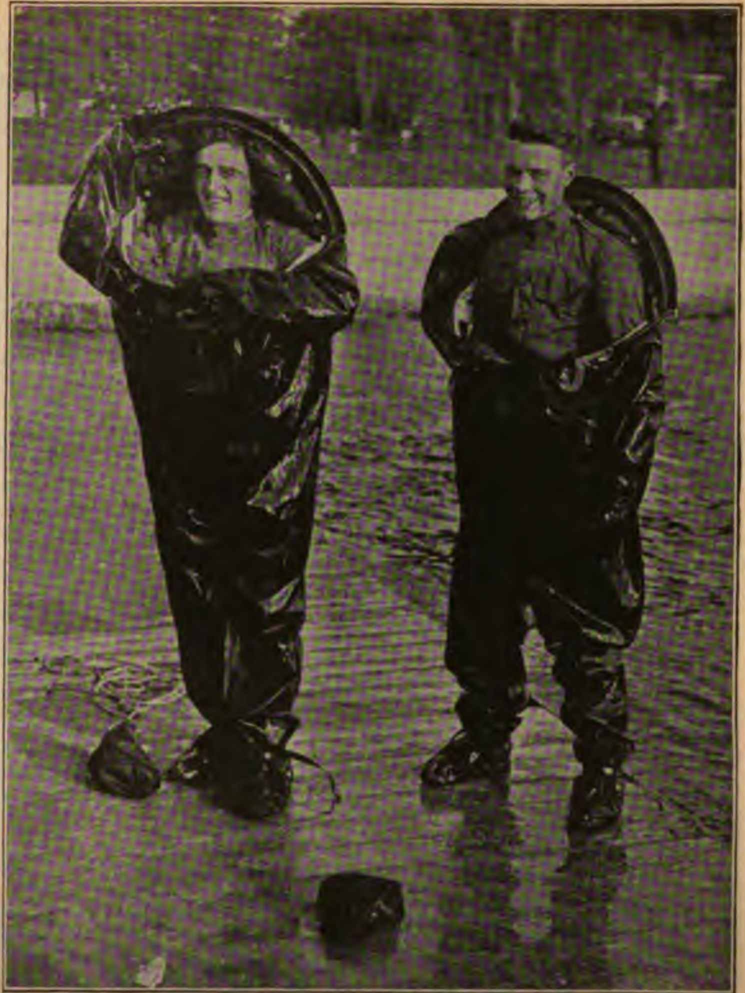
THE CLARK PEDMOBILE.

Various devices are used to enable persons having a great deal of walking to do, as those in messenger service, to cover the ground quickly and save fatigue. This is an improvement on the roller skates. The wheels are considerably enlarged, set diagonally opposite each other (to provide a steadier footing) and provided with a motor. Thus the automobile idea not only emancipates the horse but speeds up the messenger boy.



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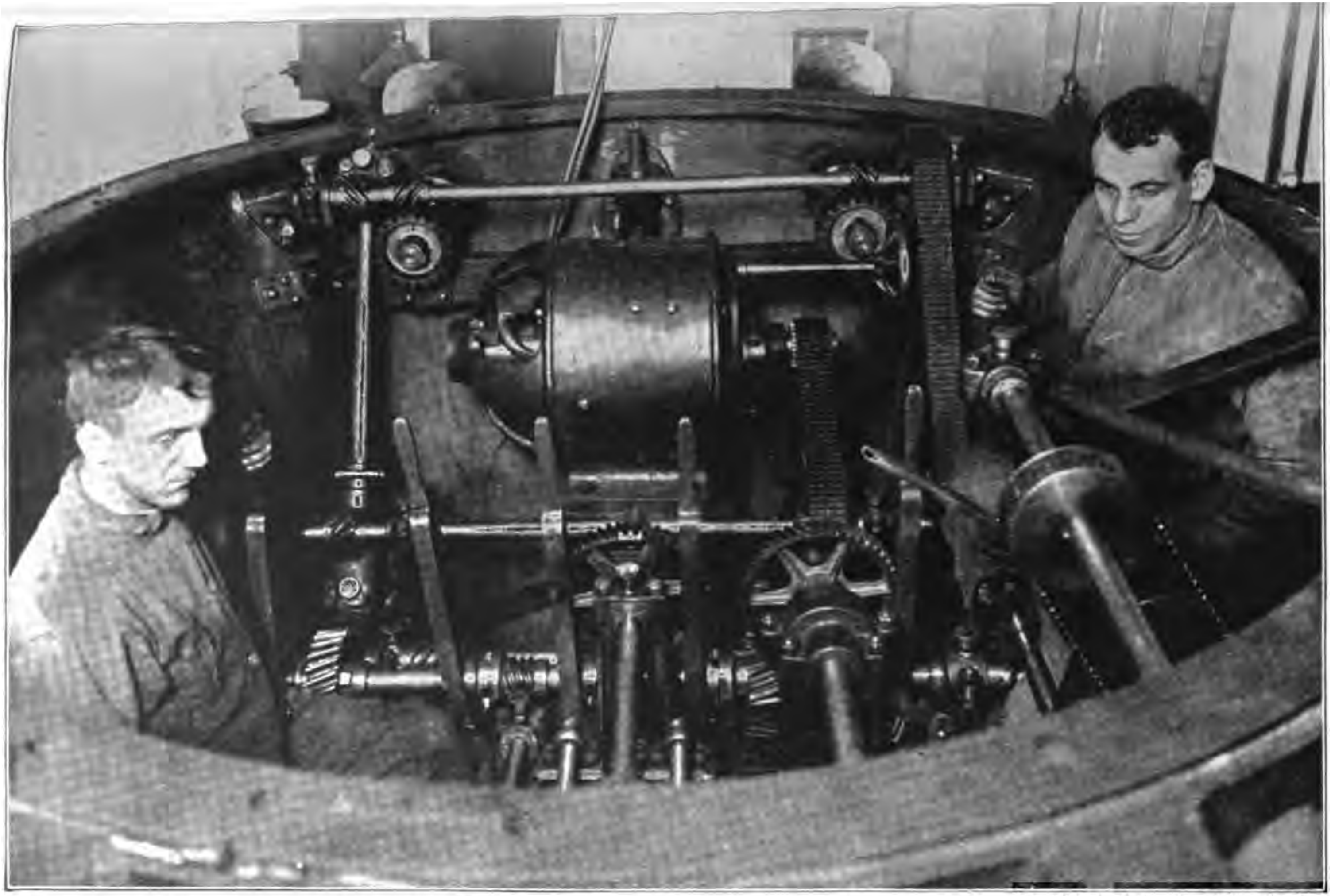
THE EVER-WARM SAFETY SUIT.

The ordinary life preserving suits keep the wearer afloat but do not protect him from exposure. This suit not only saves life, but keeps the person wearing it warm, safe and dry, while in the water, no matter how cold the weather. It has been exhaustively tested by United States army officers. Recent photographs show members of high commissions wearing such suits when passing through the submarine danger belt.



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THE CANNON BALL SUBMARINE.

The cannon ball submarine is not intended to sink ships, but to raise ships already sunk. It is a sphere, eight feet in diameter, the outer shell made of best quality steel, nearly a foot in thickness. Machinery and all it weighs sixty tons. Two operators comprise the crew. A tank on the top carries enough oxygen to last them seventy-two hours. On the outside of the shell are means for drilling, strong nitrogen lamps, and magnets to hold the submarine to the side of the ship. Pontoons, each capable of lifting 300 tons, are maneuvered into position and bolted to the side of the sunken ship.

RECENT DEVELOPMENTS IN MOTOR TRUCK ACTIVITIES.

Within recent years motor trucks have suddenly entered two new fields of business activity, the rural express and freight business, and employment on rural mail routes that, probably, will take over the express and freight business and be conducted by the general government, but that is a step yet to be taken. During the European War the railroads were unable to handle the immense amount of freight, and as a matter of necessity truck lines were established between large towns and nearby cities. This has proved such a practical innovation that it has since been systematized, well organized companies have entered the field, buildings have been erected at important terminals, large numbers of trucks have been procured which run on schedule time. They do a business that no other transportation lines can. They traverse the main country roads, pick up farm produce at the farmer's door, deliver to customers in cities, and they bring to rural homes needed supplies. Observers assert that the rapid increase of such truck lines, literally thousands of short lines having been established, is startling. Large cities are being linked up by strong companies as Washington, Baltimore and New York, and extending into New England. One company carries 200 tons of freight daily. The feeder lines for railroads in the future will be transport vehicles, gasoline driven, running over improved road from the producing vendors to the shipping points of the railroads, trolleys and inland waterways, thus developing the country on a broader scale and finally tying up every producing center with a market.

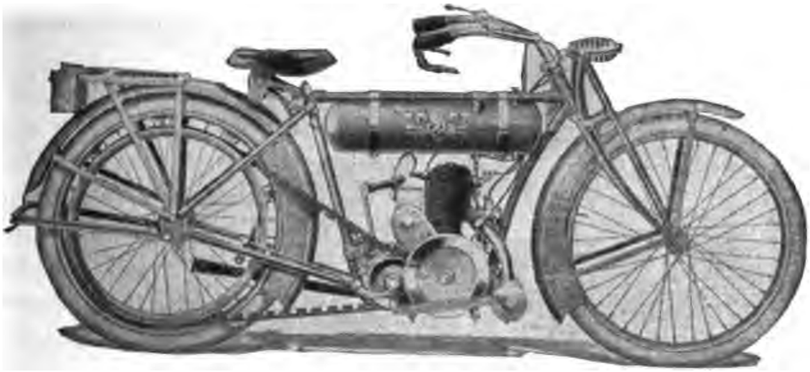
GATHERING UP MARKET SUPPLIES

THE MOTORETTE.

The motorette is a modern, small self-propelled vehicle in a class between the automobile and the motorcycle, designed to combine the low cost and light weight of the latter with the comfort and road ability of the larger motor car.

A MOTORETTE.

The first motorette was built in 1899 and was largely a copy of a small vehicle built in France in 1898 by Leon Bollee. In 1909 the Kelsey Motor Company of Hartford, Conn., invented a stabilizer which made the flexible, three-wheel motorette the easiest riding and most practical small car built.



A MOTORCYCLE.

The power plant consists of a two-cylinder opposed gasoline motor, with a bore and stroke of 3¾ inches, which is rated at 10-horse-power. Mounted directly on the motor shaft is a two-speed-with-reverse planetary transmission of the spur gear type. The drive is direct by a roller chain from the transmission to the rear wheel. The frame is of pressed steel, so designed as also to be used as the body. Directly to the frame is fastened a seat for two persons, side by side.

A motorette has been successfully run clear across the continent, on a route of 5,041 miles; has participated in the Glidden tour, and has climbed Mount Washington without stop.

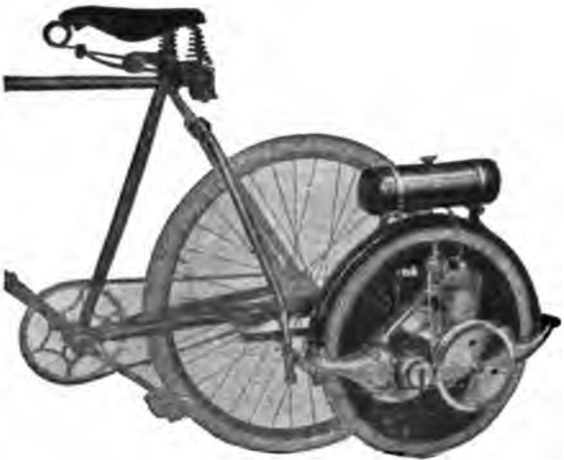
Other small inexpensive two-seated cars of both three and four-wheel type are also in successful use.

THE MOTORCYCLE.

For several years the use of the motor-propelled bicycle has been increasing by leaps and bounds until it is now a familiar sight on city streets and country roads. As a means of annihilating distance, in peace and in war, it has no equal save the automobile, while it can often go where no motor car can follow. The gasoline engine used on motorcycles is usually a single or double-cylinder motor. In a two-cylinder or twin engine, the cylinders are opposed or set at an angle opposite one another. Recent improvements, consequent upon the rapidly-growing demand for motorcycles have resulted in the development of motors and driving gear which are reliable and efficient under all kinds of road conditions, adding greatly to the comfort of motorcycling and hence to its popularity as a sport, a recreation and a valuable adjunct of business.

THE SMITH MOTOR WHEEL.

Just as a rowboat can now be turned almost instantaneously into a motorboat, by means of a portable, detachable, outboard motor, so any bicycle can be converted into a motorcycle by the attachment of the recently invented Smith Motor Wheel. This device is a complete power plant in itself and can be attached to any bicycle in five minutes. It operates and runs on its own tire, independent of the bicycle, and does not load or strain the bicycle in any way. The motor is simple and compact, free from vibration, and is operated and controlled by a little lever attached to the handle-bar. The engine is started by pedaling once or twice and it is claimed that it will run upwards of 100 miles on a gallon of gasoline. It is a one-cylinder, 4-cycle air-cooled motor of special design, the cylinder being 2⅜-inch bore, 2¼-inch stroke, and developing 1½ horse-power.



THE MOTOR WHEEL.

FARM TRACTORS.

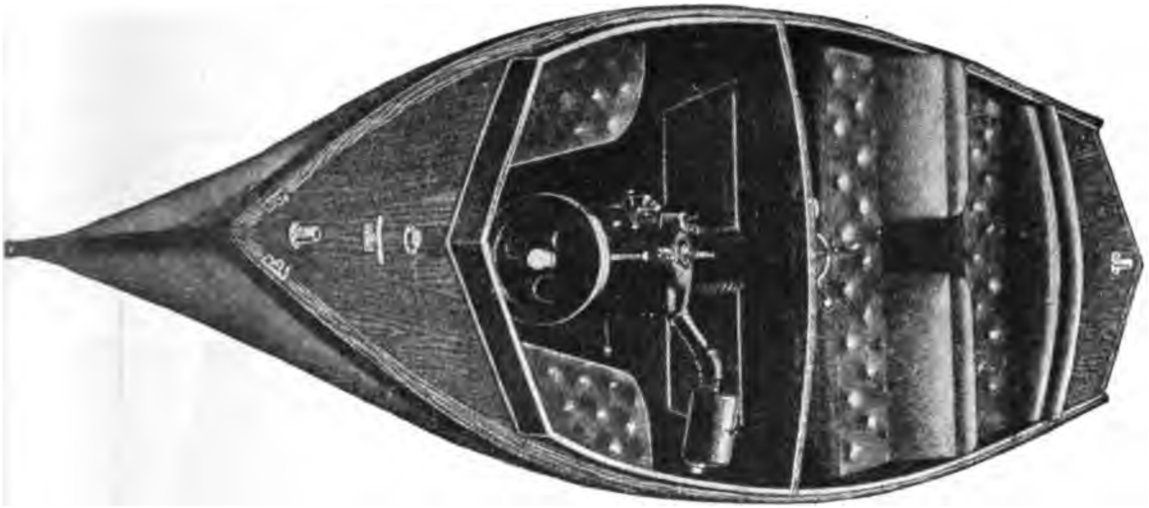
In farming, centuries ago, man power gave way to horse power, and for hundreds of years no further progress was made in farm power.

Until about ten years ago farmers were using the same power on the farm that our forefathers had used. Every other kind of power had made leaps and bounds towards economy and efficiency. Farm power alone remained as it had been, while steam and electricity revolutionized the cities and made railroads possible.

But now the Gas Tractor has brought farm power up to date and is the biggest single step in the advance of agricultural methods since history began.

The modern farm tractor, with its useful gasoline engine in fact solves many of the problems of farm labor. It will pull the farm implements, such as gang plows, harrows, mowers, binders, manure spreader, wagons, drags, and small road graders. It will operate the farmer's ensilage cutter, feed grinder, small separator, circular saw, water pump, hay baler, or practically every belt-driven machine on the farm. A typical tractor for small or large farms has a four-cylinder, two-speed gasoline motor of 12-belt horse-power. Such a tractor is of light weight, suitable for a wide range of service, and adaptable practically to all soil conditions. It has an abundance of power and is so well, and simply constructed that it gives lasting service and proves a positive boon to the farmer. Large and more powerful tractors for plowing, harrowing, harvesting and threshing are also on the market.

One man can control and operate a modern tractor and plow. After setting the levers of the plow at the depth desired, the operator need give the plow little, if any, attention. The plows are raised and lowered by the power of the motor. The power plow hoist, the plow and the tractor are one unit.



MOTOR BOAT.

KEROSENE ENGINE.

During the past few years, owing to the increased cost of gasoline, there has been a tendency on the part of engine-builders to design an engine that will operate with economy and reliability with kerosene. Several successful types have been evolved, a typical one being the Fairbanks-Morse Kerosene, two-cylinder, marine engine.

Some very radical changes appear in this type of engine, the more important being in the method of injecting the fuel. The by-pass is shaped by curving it away from and then back to the cylinder. A float chamber is attached to the by-pass at its head, with a nozzle entering the by-pass. Each cylinder is equipped with a separate fuel injection device. No carbureter is used and no fuel enters the crankcase, as is the case in two-cycle engines, using gasoline exclusively as fuel. The salient features of this type of engine are simplicity, few wearing parts, excellent fuel economy, reliability, flexibility of control and the fact that this engine can be run on either kerosene or gasoline.

Kerosene is safer than gasoline because it will not give off vapor at ordinary temperatures, thereby minimizing the danger from fire. This fact also permits of the transportation and storage of kerosene without loss by evaporation.

MOTOR BOATS.

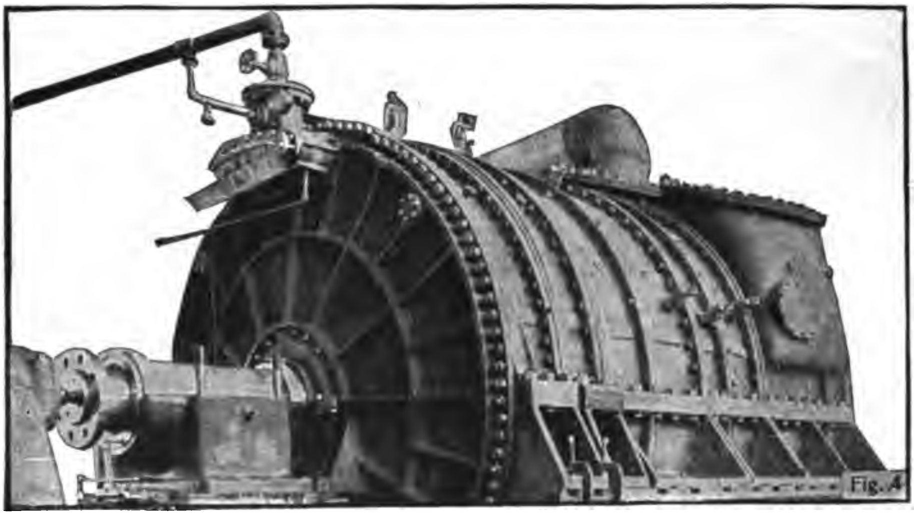
With practical perfection of the gasoline motor it has been found especially adaptable to marine purposes, and the use of motor boats for business and pleasure has been immensely increased. On the Atlantic and Pacific coasts and on the lakes and rivers of the American Continent motor craft of all sizes and all degrees of comfort and utility now abound. Outboard or portable gasoline motors to be attached to any ordinary rowboat or canoe, are also on the market and have proved convenient and useful for fishermen and pleasure-seekers.

The boats that are now propelled by gasoline or kerosene motors range in size from yacht tenders and dinghies to ocean-going cruisers. Both the United States and Canadian Governments now use these motors in their life-boat service. They are nonsinkable and self-righting and are successfully used in the worst storms of the winter seasons.

During the war motor boats armed with depth bombs, and machine guns, were used in immense numbers as submarine chasers. One of the most daring exploits of the war was the destruction of two Austrian dreadnaughts in the harbor of Pola by two small motor boats armed with torpedo tubes. The new United States submarine chasers were simply motor boats, 110 feet in length, armed with a 3-inch gun, a "Y" gun, depth charges and listening devices by which they could detect and locate submarines at a distance. We had a fleet of 123 such boats in European waters when the war ended.

THE STEAM TURBINE.

The steam turbine engine is an invention that solved the problem of power to be used in electrical generation and ship propulsion. The old reciprocating steam engine was not equal to the demand. The turbine has effected striking economies in steam consumption, attendance and installation. It has abolished pounding and vibration, eliminated cumbersome and expensive foundations, reduced the space occupied from one to two-thirds, and thereby consigned efficient but older type of equipment to the scrap heap.



A TEN-FOOT STEAM TURBINE.

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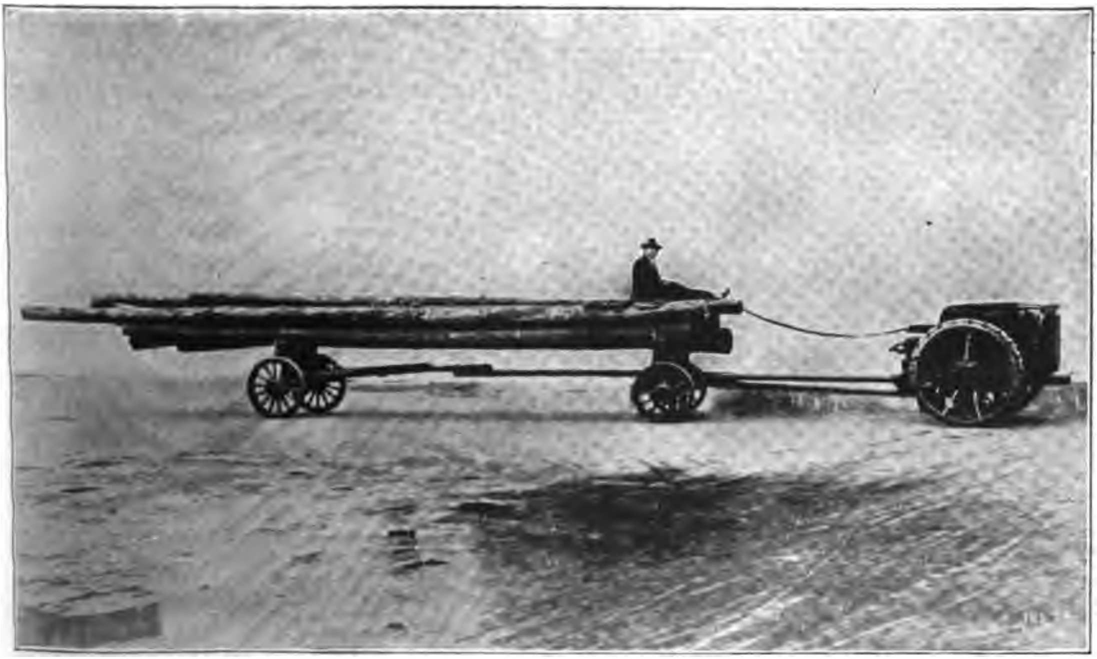
TRACTOR PLOWING IN WAR TIMES.



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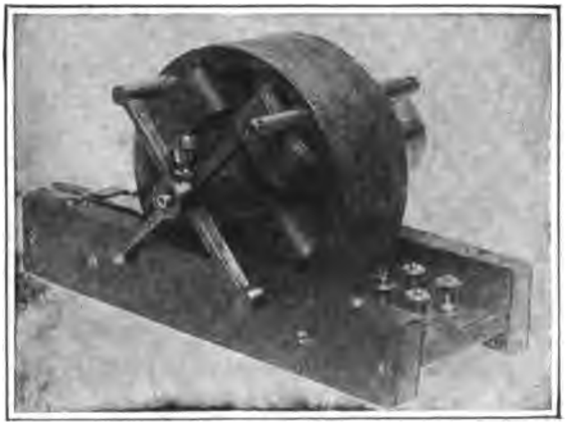
A TRACTOR DRIVEN WITH LINES.

This tractor driven with lines made to start, turn or back by pulling lines; it will pull most any kind of a load, over most any road. They are used for many purposes in the army.

Millions of horse-power are now employed in turbine-driven ships, of which the ill-fated Cunarder Lusitania was an example, and an enormous amount of power is now used in turbo-generators in the United States. The days of the reciprocating engine are passing. Electric motors are taking its place in the factory and the generation of electricity best served by turbine installation. The steam turbine was invented by the Hon. C. A. Parsons in 1884, but it did not come into commercial use until ten years later.

THE INDUCTION MOTOR.

The induction motor, constructed by Nikola Tesla in 1888, and independently suggested by Ferrari, was the first satisfactory medium provided for the purpose of transforming alternating electric current into power. When it is remembered that 90 per cent of all the electric current generated is alternating, because larger generating units can be utilized, and the current more easily transmitted, it will be seen how important was Tesla's invention. It has revolutionized power transmission and is mainly responsible for the present large and increasing use of electricity in the industries. By its means, economy and comfort have both been secured in the mill, factory and workshop. The motor being now an individual power unit, it has made power arrangement elastic, drawing upon energy only when needed and applying it directly only where wanted, and has abolished line shafting and belting.



TESLA'S INDUCTION MOTOR.

COMPRESSED AIR.

The use of compressed air for power purposes is now very common and many air compressors have been invented. The extent to which it can be compressed depends only upon the strength of inclosing vessel. It is used on exactly the same principle that steam is used, but we can all see it can be employed where steam is out of the question. In mining operations in boring tunnels, etc., compressed air is used to drive the drills. In submarine boats much of the machinery is driven by compressed air. The use of the air brake on our trains is, of course, familiar to all. In modern days the value of compressed air has become so apparent that every large city, and many smaller places, are making some use of this power. Some of the larger cities use it as a means of transmission of mail packages, etc., about the city, from place to place. This type of pneumatic tube is the most advanced and it is only of recent development.

PNEUMATIC TUBES.

The most common use to which compressed air is put for carrying purposes is that in pneumatic tubes in the great stores.

hotels and newspaper offices. By means of brass tubes leading from a central station to every section of a store, or to the numerous rooms of a hotel, power is conveyed. At the central station there is a pump which develops an air pressure of about 2 pounds to the square inch of pipe surface. For long distances and for great speed, where much use is made of the system, greater power is necessary.

In each station where the tube is used there is a receiving and sending apparatus. Two pipes complete the circuit, one with air traveling away from the central station and the other with it rushing toward the home plant. The sending device differs according to the necessities of the occasion. Many plants which do not need heavy pressure simply have an opening in the tube covered by a lid. When it is desired to send something, a small leather or metal box conical in shape, and with furry ends to make it fit closely to the tube, is opened, and the article is enclosed, after which the sending box is closed and dropped into the tube. It takes only a few minutes for this box to travel about a mile. When it reaches its destination it falls into a box which is provided with a door, and is so arranged that the power may be cut off before opening it to take out the carrier. Some receivers simply have a lid held in place by a strong spring, so that when the carrier is forced against it, it gives way and the carrier falls out upon a desk.

ITS SERVICE IN GREAT HOTELS AND STORES.

By means of these pneumatic tubes money for payment of articles is carried in stores from sales clerk to cashier and the change and receipt for the purchases are returned. In hotels, mail is delivered over the entire building, sometimes over 15 floors or more. Newspapers, calling cards, etc., are also sent to guests.

ITS RELATION TO NEWSPAPER WORK.

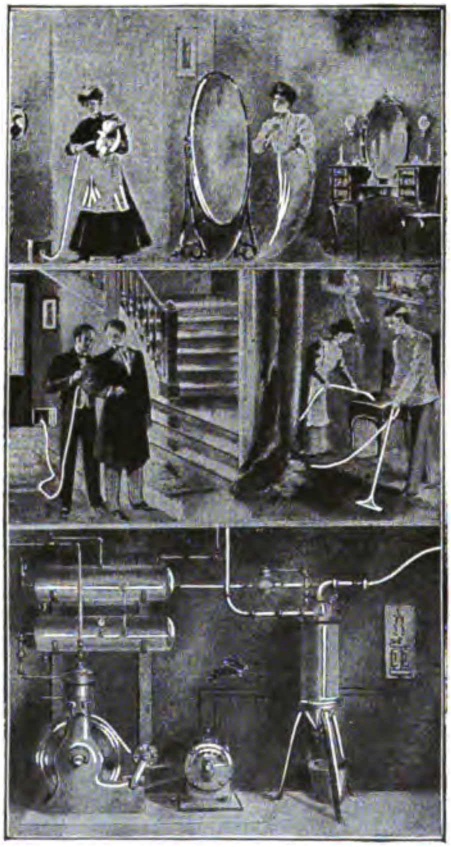
In newspaper offices, these tubes play an invaluable part. All the copy for news matter, advertisements, etc., is "spouted" to the composing room with great rapidity, thus saving the bother of a host of messenger boys, as well as doing the work without loss of time. One feature of the newspaper work is the great pneumatic tube service in the large cities, in use by newspaper associations. Such bureaus as the great Associated Press, which sends out tens of thousands of words of news matter daily, could never do so speedily were it not for the great serpentine tubes that wind about below the city pavements connecting its headquarters with every newspaper office which receives its service. By this means the "hottest" news is shot over to the newspapers in time for publication, whereas were messengers used, the delay might be vital.

USEFUL IN THE POST OFFICE.

Of late years the United States Post Office Department has been an active user of compressed air. Several cities are now served by pneumatic tubes and are able to send mail from postal headquarters to branch stations with very little loss of time. Packages weighing several pounds may also be sent. One of the greatest of these systems will shortly be in operation in Chicago. The cost will be many millions of dollars, but the improved service in dispatching mails and in collecting them will amply repay for the outlay.

CLEANING FURNITURE, CARPETS AND RAILWAY COACHES.

Aside from the use of compressed air in pneumatic tubes, this agent has been found valuable in many other ways. One of the most common uses to-day is that in cleaning. A hose is attached to a compressed air pump and by means of a nozzle which may be opened or closed at will, a stream of compressed air is directed against upholstered furniture, carpets, and many such articles that gather dust readily. The effect is a cleaning operation of marvelous rapidity. In this manner the coaches of a railway are cleaned after every trip. In the large cities it is no uncommon sight to see a van drive up to a large office building. From this vehicle is unreeled a hose attached to a compressed air machine. The hose is pulled up through a window on, perhaps the twentieth floor, and carpets are cleaned on the floor, and chairs, sofas, etc., are renovated.



CLEANING WITH AIR.

FOR MOTIVE POWER.

Compressed air serves many other purposes, where power is needed. By it ladders are raised or lowered, elevators and automobiles are operated and engines are run by this means.

THE PHONOGRAPH.

Many people can easily recall the first phonograph and the excitement occasioned by the invention. For a long time it seemed as if the phonograph was only an ingenious scientific toy, but many practical applications for this principle have been found. As all know its value consists in its ability to make a register of sounds—ordinary conversation, a song or an oration—and afterwards by use of the record repeat whatever was so recorded so that it can again be heard and understood. The record may be a wax cylinder or a flat disk.

THE DISK RECORD.

No thoughtful student can examine one of these records, observe the faint and almost indistinguishable markings on the surface, without a feeling of wonder that they constitute a veritable record which can be made perfectly legible of songs, conversation or oration which produced them.

Elevated over the cylinder and moving along its listance as the machine is set in motion, is a funnel which gathers up the sound waves. At the end of this funnel is a small drum-like affair made of thin metal, upon which is fastened a tiny stylus or pen. When sound is directed into the funnel, it agitates the drum membrane, which in turn scratches a record of the waves into the wax of the cylinder. Each sound wave has a peculiar motion unlike any other. Therefore, when the cylinder has been revolved its entire distance and the pen has scratched the song into the wax, it should be a perfect record of that song only. Such is the case and now it remains to reproduce the sound.

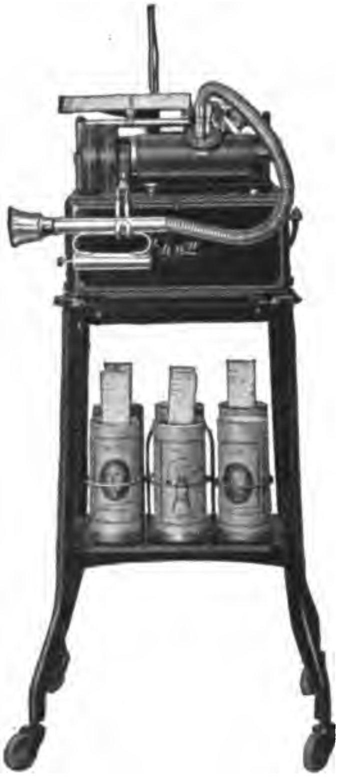
A Modern Phonograph.

Another drum is attached which has a reproducing stylus similar to the recording one, but of a nature that will not scratch. This pen runs along into all the little scratches made in the record, and agitates the drum membrane in just the reverse manner that it was agitated when the sounds were sent into the funnel first. This agitation causes the metal drum to give off sounds that very closely imitate those that first went into the phonograph. The motive power to revolve the cylinder is generally developed from a small electric battery attached to it, although clockwork will run one for a few minutes.

THE EDISON DICTATING MACHINE.

Thomas A. Edison has continued for many years to develop his original discovery of the Phonograph. The wide and practical scope of his recent work is shown, first, in the recording of the faintest sounds upon a stage and their magnification into great volume under perfect synchronism for the "talking-pictures" (the Kinetophone); second, in the marked improvement of musical reproduction with indestructible records and diamond points on his new Diamond Disc Phonograph; and, third, in the accurate results acquired in the Dictating Machine, which, unlike the other instruments, must fit conveniently into the business office as a counterpart of human intelligence.

The Edison Dictating Machine is of pressed steel construction in pedestal, cylinder rack and cabinet. The mechanism is of uniform design for practical use in both dictation and typewriting departments. The voice of the person dictating is recorded on wax cylinders of the well-known Edison phonograph type, from which everything spoken may be easily transcribed by a typewriter at any time.



THE EDISON DICTATING MACHINE.

Edison has lately added comfort for the operator—as well as increased efficiency—with the Transophone. In this device the repeating of the voice is accomplished electrically by a tap on a button attached to the typewriter keyboard.

EDISON'S TELESCRIBE.

Recently Mr. Edison perfected the "Telescribe." This invention consists of a sensitive telephone for desk use with controlling buttons to operate a recording machine near by. It is so sensitive and so adjusted that the slightest vibration is recorded.

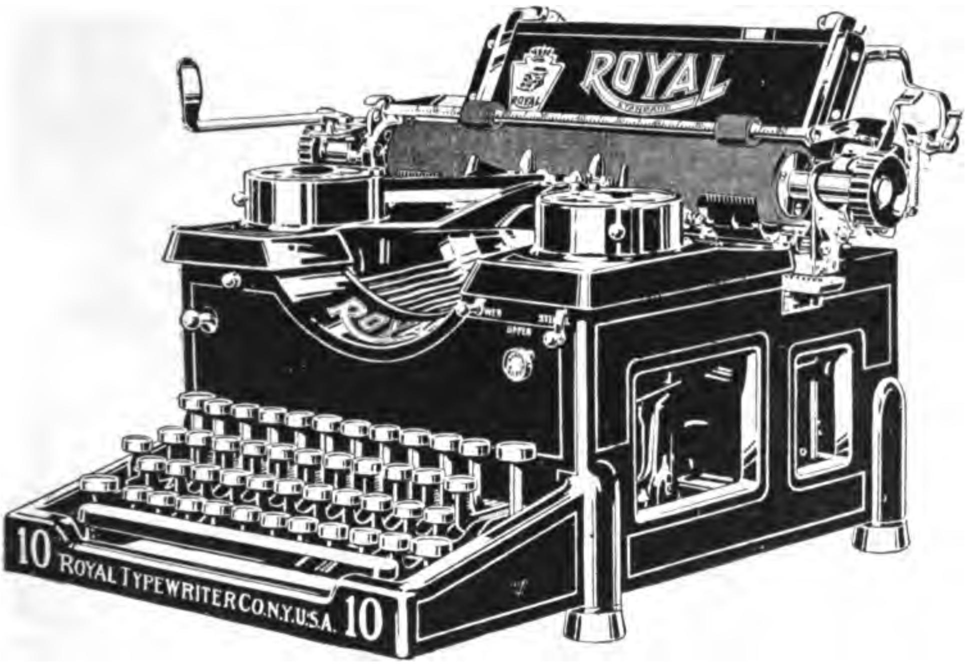
More than a generation of invention and scientific development is centered in the new apparatus, which makes the telephone more useful, the phonograph more valuable, and both more necessary. In effect, this is dictating at a distance and the record can be preserved for future reference.

WRITING MACHINES.

The development and use of writing machines in the last decade have kept pace with the growth of business. The commercial correspondence of the world is now carried on mainly by the aid of the typewriter and the useful machine has also made itself valuable in bookkeeping, billing and tabulating, besides a variety of other record-making services in which it secures neatness, rapidity and accuracy. It has become invaluable to the author, the editor, the newspaper man, and the printer. Telegraph, cable and wireless messages are quickly transcribed by its aid and it is now found performing its rapid and efficient service in thousands of American homes as well as in all business offices and counting-houses.

THE STENOTYPE.

One of the latest machines for rapid writing is the "Stenotype," which is claimed to be the fastest writing machine in the world. This is a machine similar in construction to a typewriter, but smaller, lighter and noiseless. It does not displace the typewriter, but is a companion machine to it. It writes, or prints, in plain alphabet type, but writes a word at a time. Instead of striking only one key, as in ordinary typewriting, the operator of the stenotype strikes three, six, ten, or any number of keys all at the same time. While some of the longer words require two or more strokes, it is frequently possible to write two or more words at a stroke—often a whole phrase at a single stroke.


ROYAL
ROYAL
10 ROYAL TYPEWRITER CO. N.Y. U.S.A. 10

The Stenotype writes what is termed "stenotypy," a system of plain English letters with only the silent letters dropped. The system is taught in many business colleges. One advantage is that any stenotypist can read the notes made on the machine by any other. The writing is done on a strip of paper similar to that used on an adding machine and is automatically spaced. The machine weighs only 8 pounds.

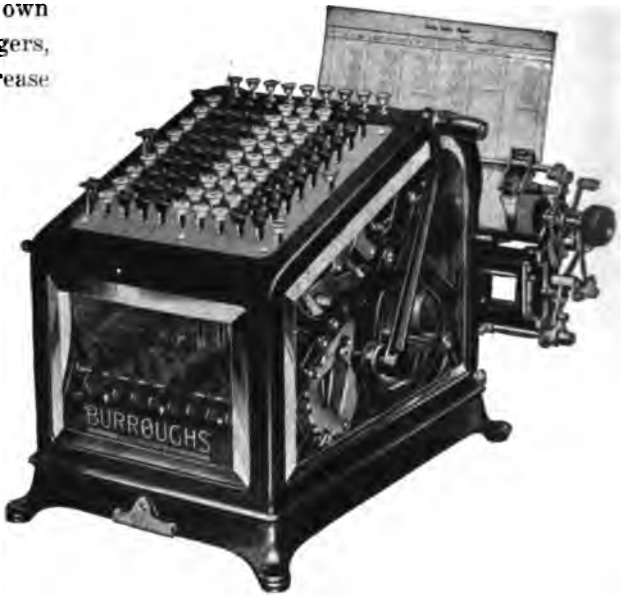
THE STENOTYPE.

CALCULATING MACHINES.

An interesting development of commercial devices in recent years has been the perfection of various calculating machines which are now in common use in business offices. Among these may be mentioned the Felt & Tarrant Comptometer, and the Burroughs adding, calculating and bookkeeping machines.

The calculating machines now in use are capable of a great many high-speed operations. They will add, subtract, multiply, and divide with equal facility; will do their own printing, make up payrolls, post ledgers, check invoices, figure percentages, increase the speed and accuracy of the most experienced office man and make the slow figure-man an expert by their use.

The Burroughs Duplex Multiple Total Machine, with 17 columns of keys, and an adding capacity of 34 figures, is said to be the biggest adding machine in the world. The ordinary adding machine has one set of "adding wheels." The new Duplex is made with two sets of wheels and the result is a machine that will add two separate sets of figures at the same time, both printed in the same column or in separate columns. There are many possibilities in business for such a machine.



THE BURROUGHS CALCULATING MACHINE.

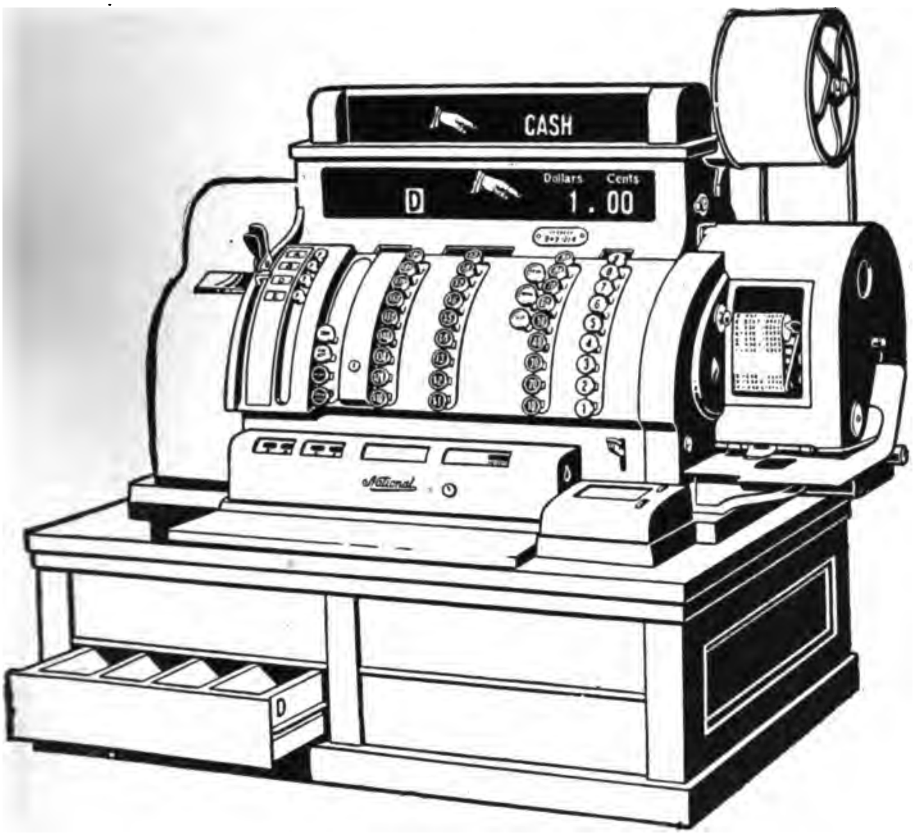
THE ENSIGN.

THE ENSIGN ELECTRIC CALCULATOR.

Another mechanical calculator of merit is the Ensign Electric Calculating machine, invented a few years ago by Emory S. Ensign of Boston. This machine multiplies, adds, divides and subtracts. It is an automatic, electrically driven machine, easily operated by a novice. It has a proof meter which automatically registers a proof of the operation and has been in daily use in many large business offices for several years.

THE CASH REGISTER.

No form of calculating machine is in such general use as the various forms of cash registers. In stores, restaurants, and hotels this great modern convenience is in use. It will faithfully keep count of all the money received so that a glance at any time shows the amount the register should contain. There are a great many varieties in use. A common form has a number of keys, each

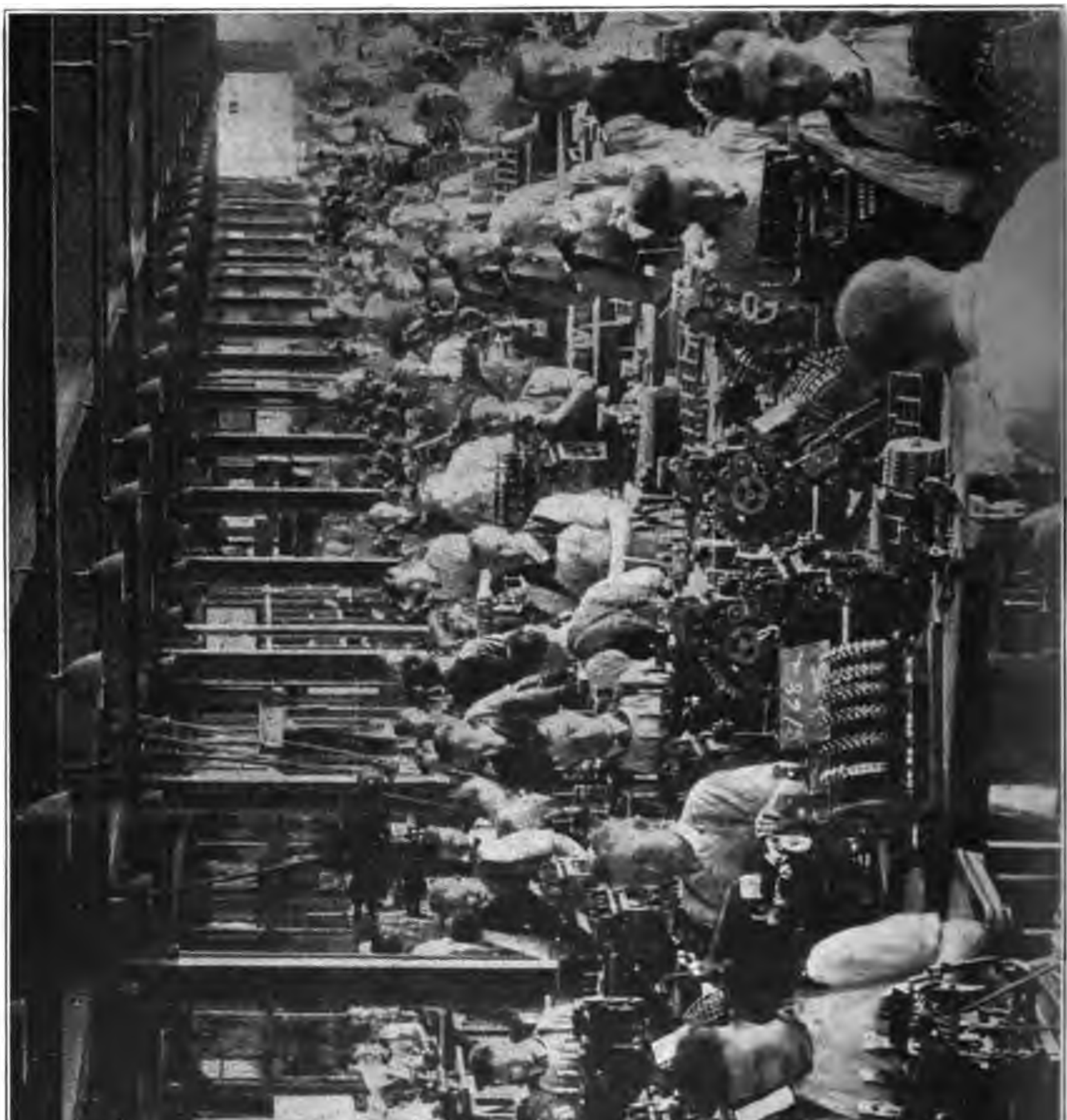


THE CASH REGISTER.

representing a particular sum and each attached to a counting mechanism. There are more than 7,000 different parts in this register. It will indicate at the top the kind of sale, just below tell which clerk made the sale and the amount of the same. Further to the right, on a strip of paper in plain view this amount is printed in duplicate. Just below the printed slip a ticket to be handed the customer is thrown out, containing the information just enumerated. A drawer is thrown open so that the proceeds of the sale may be placed in it separately. The machine, by operating the proper keys for cash, charge, received on account, or paid out will register these amounts separately. The register is now built to record separately the number of sales made by eighteen clerks, totaling the amounts of such sales on individual counters, and the total amount of all sales of the store registered on the one main counter just above the keys.

MINE RESCUE TELEPHONE EQUIPMENT.

The United States Bureau of Mines has men drilled for rescue work. In case of an accident in a mine, they at once proceed to the place and being provided with a gas mask can work amid surroundings ordinarily fatal. There has been lacking, however, until recently a means of keeping the advance or rescue party in close communication with the party near the entrance of



INTERIOR OF THE CASH REGISTER FACTORY

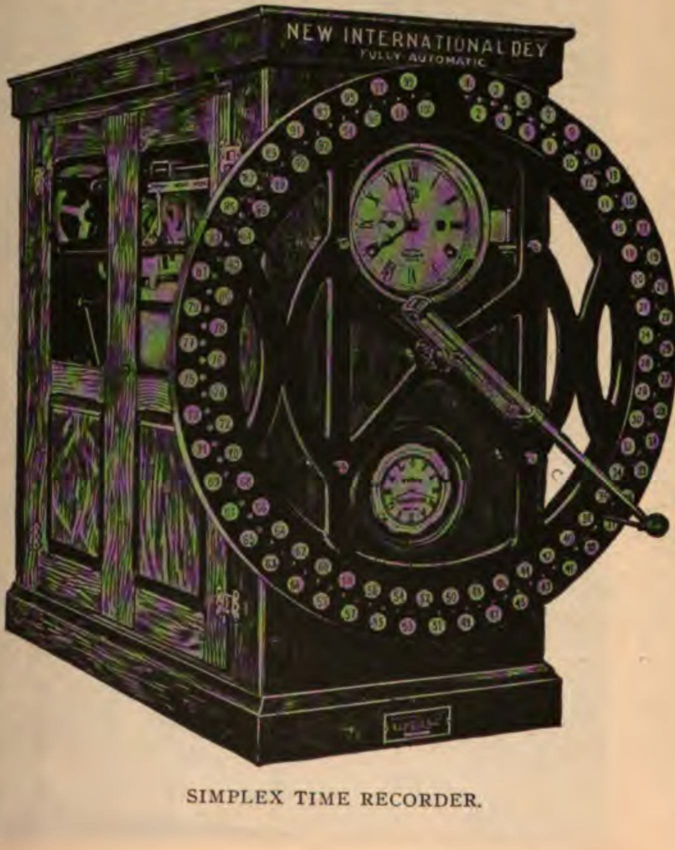
ONE OF THE MINE RESCUE CREWS.

the mine. The need of this was recognized by the United States Bureau of Mines as well as by some of the large mining interests. Experiments were made, and it is now possible to obtain a light, serviceable and simple telephone equipment which will meet all the requirements of this unusually severe class of work. The equipment included a new form of transmitter, specially designed to prevent interference with breathing when the rescuer is wearing an oxygen helmet.

THE TIME RECORDER.

Constantly increasing competition in all commercial lines demands the strictest economy in every department of any establishment employing a number of workers, and it is now generally regarded as essential that exact and systematic methods of recording and computing employees' time be used.

For this purpose many mechanical time recorders have been invented in recent years. One of the best known and most successful is the Simplex Time Recorder, manufactured at Garden, Mass. This device is remarkable for its simplicity.

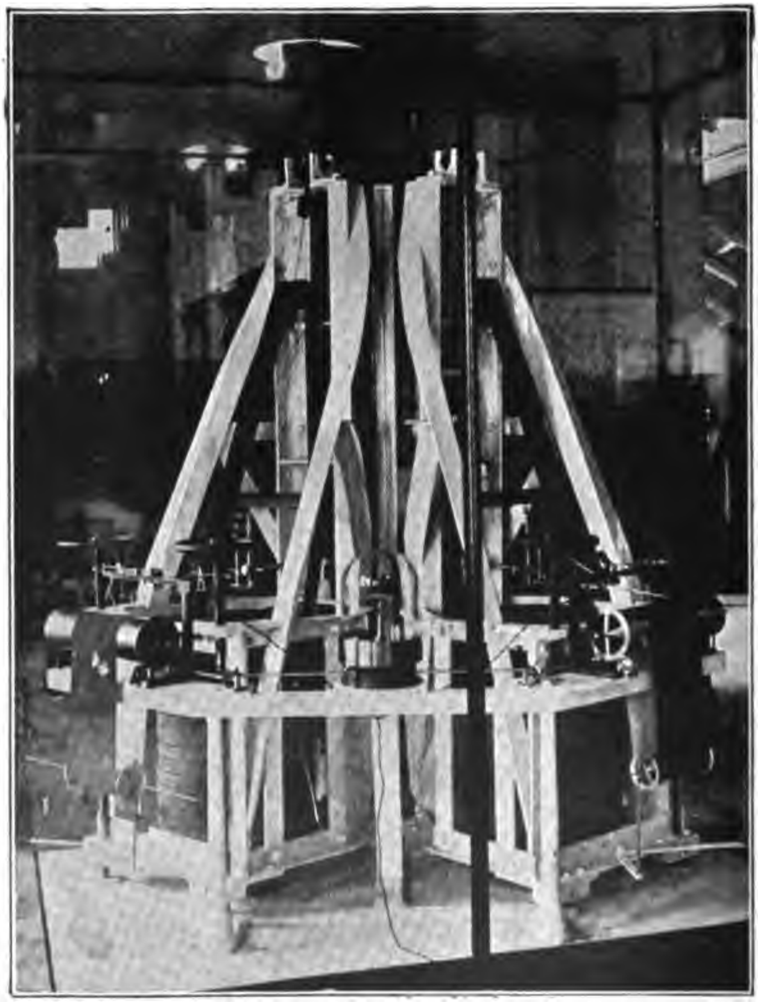


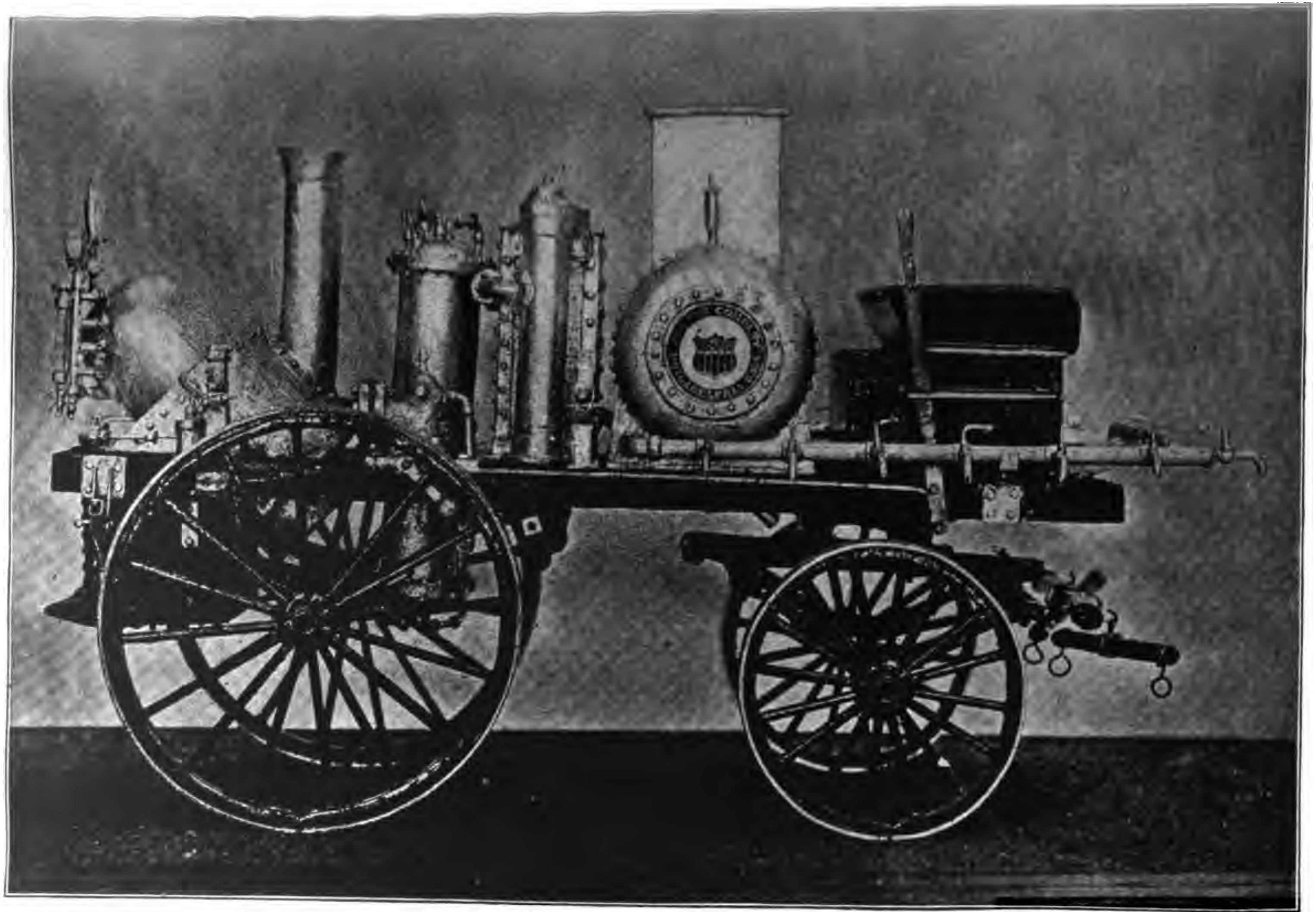
SIMPLEX TIME RECORDER.

THE SEISMOGRAPH.

In the field of pure science we must refer to the Seismograph. At present no practical results are seen to follow this invention, it is, however, of great interest scientifically and one can never tell when a practical application will be found for an invention devoted to furthering scientific ends.

This seismograph or earthquake recorder is located in the New York Academy of Science. It rests on a pier built up from foundation rock; so it will not be affected by surface tremors, only those from the depths. On strips of paper passing over the rolls are recorded the time when the vibration reached New York, the amplitude of the same, and other details, from which can be determined the severity of the shock, and whether the movement was oscillatory or to and fro. Comparison with other seismographic information enables us to determine the rapidity of travel of the vibration and the approximate distance beneath the surface of the disturbance. The earth's crust is in an almost constant tremor, machines of this kind are so sensitive that they will register the vibration due to an excessive rainfall some miles away.





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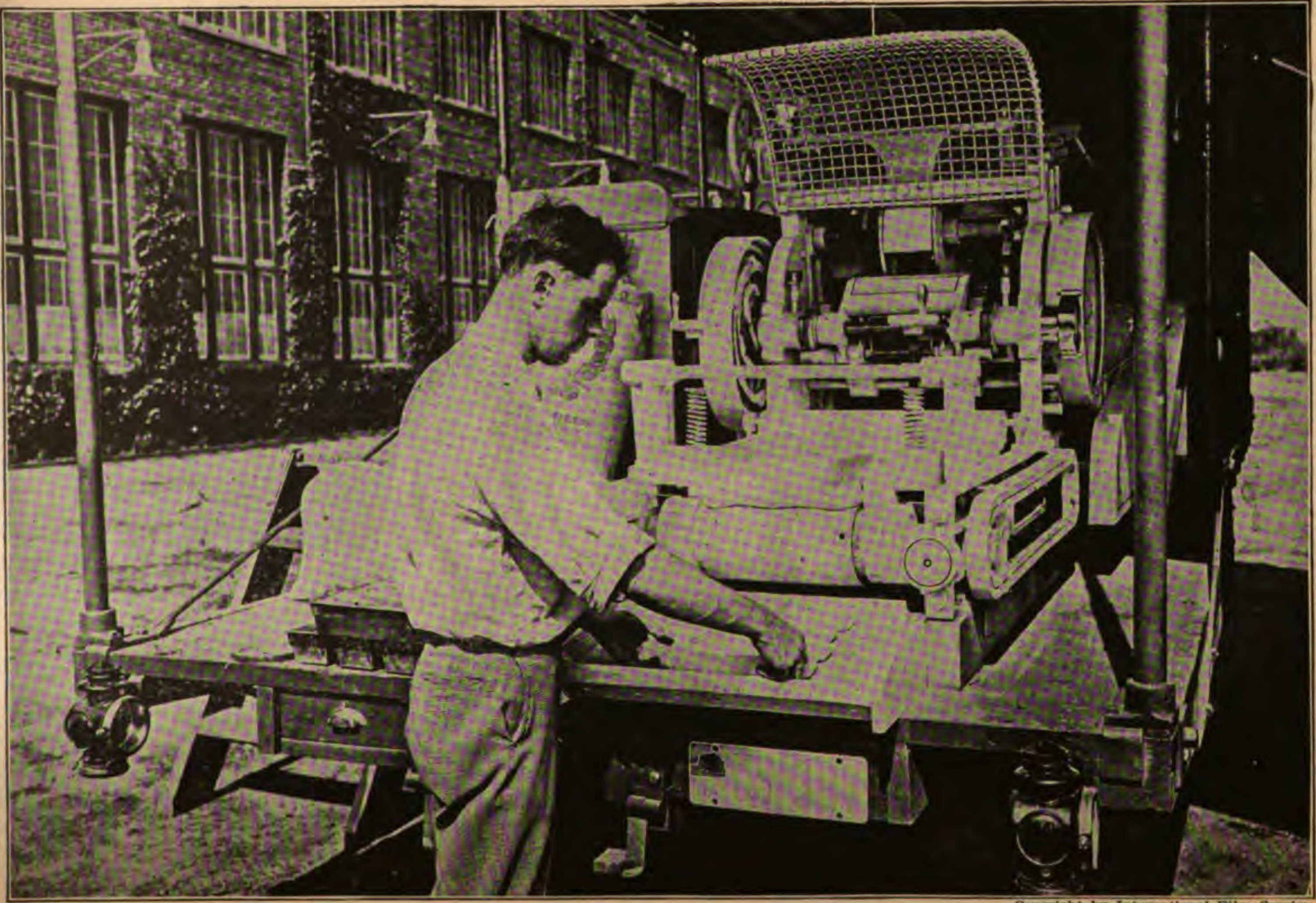
THE FORBES STERILIZING MACHINE.

It is absolutely necessary that water used for army purposes should be sterilized. Sand filtration does not remove germs of disease such as those of typhoid fever and intestinal troubles. To destroy such germs, recourse must be had to chemical treatment. The material most generally used for that purpose is some form of chlorine, usually chloride of lime. Liquid chlorine generated by electrolysis of brine is better on some accounts. This machine is the one employed by the United States to purify the water for its army.



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UNCLE SAM'S BREAD MAKING OUTFIT.

Six thousand loaves of bread an hour can be made by this bakery on wheels. It consists of an automatic dough mixer, a loaf divider and moulder, with a full equipment of utensils. It can be set up near the battle front, in field camps, or in cantonments. With this outfit, five men can do the work of over a hundred bakers and the output is made in a cleanly, scientific way, as all unsanitary handling of dough is avoided. It is said to be the only unit bread making machine in existence. It can be operated either by the truck

THE SOLAR FURNACE

POWER FROM THE SUN.

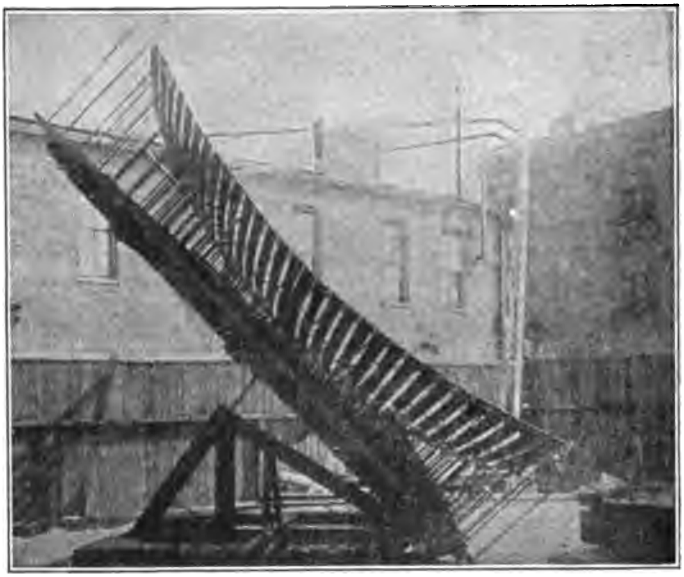
A wonderful new invention, running steam engines, smelting all kinds of ores and minerals, heating and lighting houses and cooking all kinds of food, either day or night, by heat of the sun's rays, without fire, fuel or expense, is the Solar Furnace.

STEAM ENGINES.

For running steam engines the sun's rays are concentrated by means of curved reflectors onto a specially built high-pressure boiler, the heat being so intense that the water is turned into steam very fast, two square yards of sunlight furnishing sufficient heat to develop one horse-power, the sunlight falling on a space 44 feet square, furnishing sufficient heat to run a 100 horse-power steam engine. Any engine can be used, but a specially built boiler is necessary. The reflector is mounted on a revolving base and moved by a clock-work attachment that keeps it in focus with the sun all day.

PUMPING PLANTS.

It is thought by some that the solar furnace will revolutionize the present irrigation system, especially in the Southwest, where water is scarce and fuel high. Any amount of water and fuel can be pumped from either deep or shallow wells; no fuel is required, and when a plant is once installed the expense is ended. On all pumping plants requiring over five horse-power, a steam engine is used, the steam being generated by the heat of the sun, as above stated. On plants of five horse-power or less, a "compression" engine with pump attached is used. No fire, fuel, steam, or water is used; nothing but sunlight and air. It is impossible for it to "blow up" or explode. It works automatically, and no engineer is required.



By courtesy of the Solar-Furnace and Power Co.
SOLAR FURNACE (SIDE VIEW).

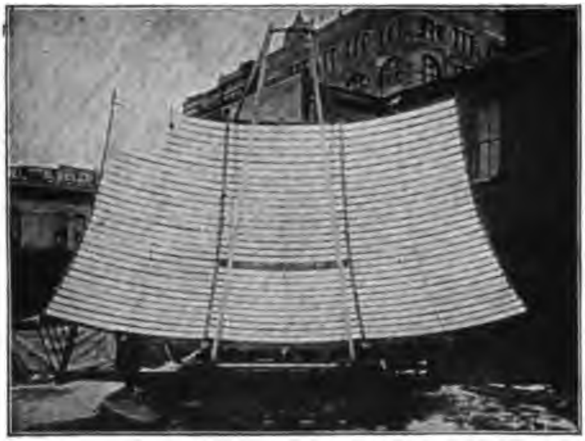
A small plant may be made to pump sufficient water for a large tract by having a reservoir and running the pump every day when the sun shines, using the water only as needed.

SMELTING ORES AND MINERALS.

Any and all kinds of minerals can be smelted, or literally "burned up," if desired. A single yard of sunlight will melt silver, gold, glass or wrought iron to a liquid, while two yards square of sunlight will develop heat of over 25,000 degrees, or more than one hundred times as hot as boiling water.

HOUSEHOLD USE.

A small plant can be installed on roof of the house at a cost of only a few dollars. Attached to the water hydrant, it works automatically and carries steam down through pipes to the kitchen, where it is attached to a steam cooker cooking a dozen different kinds of food at the same time without fire, fuel or expense, and furnishing boiling water for the bath, the laundry and all other purposes.



SOLAR FURNACE (FRONT VIEW).

STORING HEAT AND POWER.

Electric power is generated by a steam engine run by the solar furnace during the daytime and stored up in a storage battery to run machinery, and for heating, lighting, cooking, and other purposes nights and cloudy days. The possibilities of the solar furnace are practically unlimited.

RECENT DEVELOPMENT.

Recently most important sun-power plants have been installed, one near Philadelphia and one at Meadi, near Cairo, Egypt. The Egyptian plant promises to be very important. The proprietors expended very large sums of money in investigation and preliminary work. They think they have solved the problem of the successful application of this greatest of all natural forces. But it must be remembered that Egypt presents features that strongly assist such work, that are not present in all locations. The sunshine, for instance, is constant. Undoubtedly this plant will accomplish great results in the way of pumping water for irrigation purposes.

ACETYLENE GAS, THE LATEST ARTIFICIAL LIGHT.

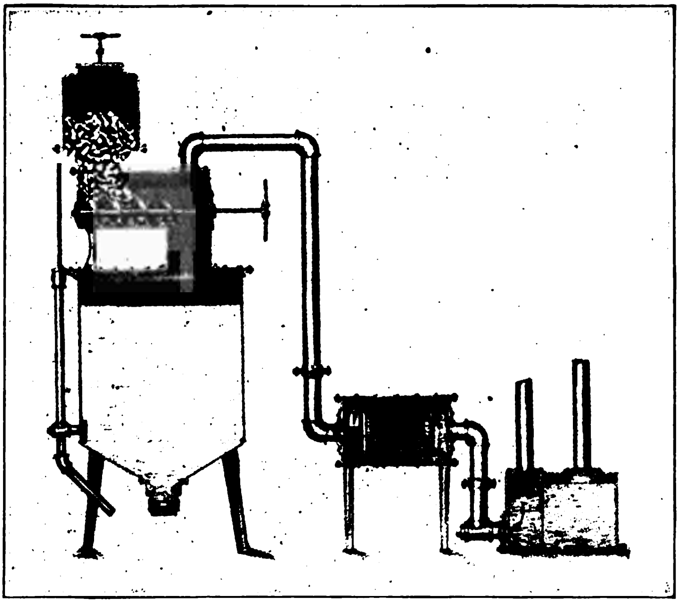
Acetylene gas is given off when calcium carbide is put into water. Calcium, or calcium carbide, is a hard, porous, grayish material produced by fusing pulverized coke and air-slaked lime in an electrical furnace. One ton of this substance will make 11,000 feet of acetylene gas, which is equal in illuminating power to about 264,000 cubic feet of ordinary city illuminating gas. The method of making the calcium carbide varies according to the purity and strength of the gas wished. The electric furnace is used and the following method is employed.

Two thousand pounds of lime and 1,500 pounds of coke are placed in an electrical furnace. The lime is crushed and pulverized by suitable machinery and is slowly air-slaked and then thoroughly mixed with the coke. In the bottom of the electrical furnace is a cast-iron crucible, and the bot-

TWENTY-LIGHT GENERATOR, CARBIDE CHARGE, 16 POUNDS.

tom is protected by a thick layer of powdered carbon, which is a good conductor of electricity, but a poor conductor of heat. This bottom plate forms one of the electrodes of the electric cable which conveys the electricity to the furnace. The other electrode of the cable is a large carbon "pencil," attached to the wires that run to an alternating electrical generator. This pencil is let down into the mass in the crucible, and the electricity being turned on, something like an arc light is formed. Intense heat is developed and the coke and lime are fused, producing the calcium carbide.

The calcium remains unchanged in dry air, but if subjected to moisture it gives off a thick heavy gas which smells like garlic. This is acetylene. All that is necessary to do is to control it so that it may issue from a jet in suitable quantities, and then light it. The light given off is of a very brilliant and powerful greenish hue. This gas is highly explosive unless handled carefully. It is being used in great quantities, however, and especially convenient is it on automobiles, carriages, bicycles and for country places where ordinary gas cannot be obtained. The lamp used for vehicles consists simply of a small reservoir, from which water is allowed to trickle upon a quantity of calcium carbide contained in another gas-tight receptacle. From this latter reservoir, leads a small pipe to the gas burner. A match is applied when the gas is generated.



By courtesy of the Acetylene Apparatus M'f'g Co.
ACETYLENE GAS GENERATOR, FOR A TOWN.

BREAD SUPPLIED FROM THE ATMOSPHERE

MR. CHARLES S. BRADLEY.

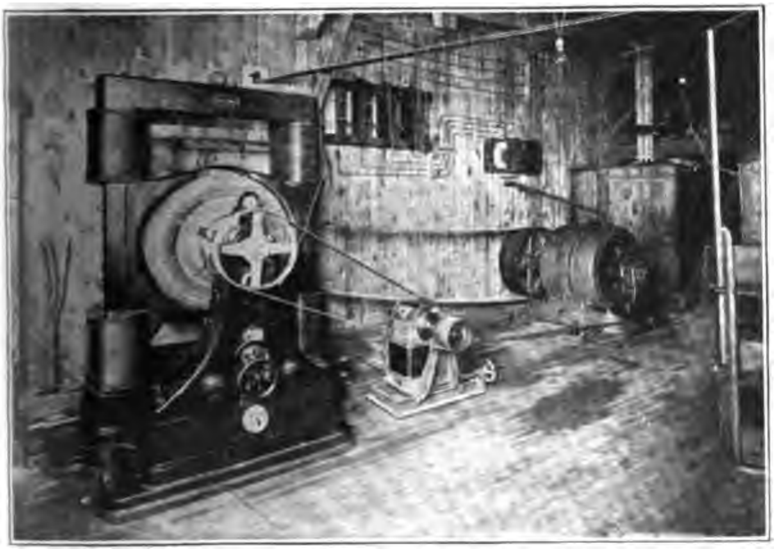
Back in 1898, the scientific world was alarmed by the statement of Sir William Crookes to the effect that the bread supply of the world was threatened with exhaustion. Sensational as the remarkable analysis of the situation was, nevertheless, the statement remains broadly true that unless something develops to take the place of the rapidly diminishing supply of nitrogenous fertilizers, the world's wheat supply is sorely threatened by the failing fertility of the soil. Summed up, the eminent scientist's statement was that the world's low average of less than thirteen bushels of wheat per acre means literal starvation for the rapidly increasing nations of wheat eaters, unless aid comes.

NITRATES ESSENTIAL TO WHEAT GROWTH.

MR. D. R. LOVEJOY.

Nitrates supply the fertile qualities of wheat growth, but what of the great and growing wheat areas that before long must starve for soil nutriment? The nitrate deposits of Chile are swiftly being depleted. The guano beds of the islands of the Pacific even now are cleaned up. The phosphatic beds of the South are strictly limited. Fixed nitrogen in refuse is thrown away with alarming prodigality. Now one hears the prediction that barely 30 years hence it will take 3,200,000,000 bushels of wheat annually to feed the world. This, it is estimated, will necessitate the use of 12,000,000 tons of nitrate of soda a year, over and above the 1,250,000 now used. But the nitrates in sight now promise a supply for only 50 years. The problem thus is serious in the extreme.

Science, however, is coming to the rescue. Spurred on by the timely warning of Sir William Crookes, scientists all over the world are endeavoring to develop artificial means of producing nitrogen in quantities sufficient not only to supply present needs, but to lay up goodly stores for the future. Be it known that there is nitrogen in superabundance in the very atmosphere we breathe. On every square yard of the earth's surface nitrogen is pressing in the form of gas in the air, with a weight of seven tons. The question that is perplexing inventors is that of developing a means of "fixing," or extracting it from the air at a little cost. Chilean nitrate costs $37.50 a ton, while commercial nitric acid costs $80 a ton. It is with the ceaseless power of Niagara Falls that enough electricity is derived to extract nitrogen from the air so that nitrate of soda ought to be produced at not more than $25 a ton.



General View of Arc Machine on left driven by Motor at the right, receiving its current from Niagara Power Plant.

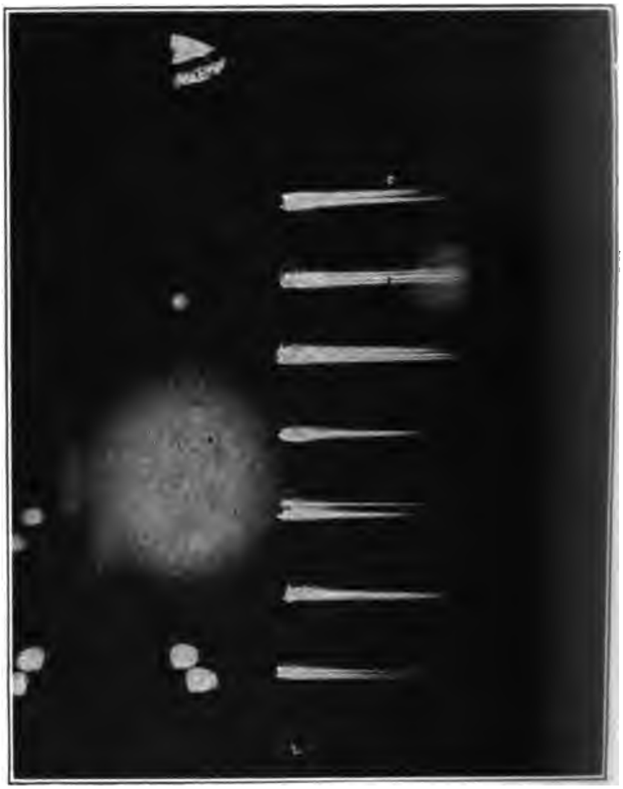
Several inventors now have stepped forward in the unique quest for bread from the atmosphere and have erected experimental stations at Niagara Falls. As far back as 1785, Dr. Priestly noted the fact that when a spark of electricity was discharged through the atmosphere the air underwent a chemical change. Any one notices the change in the air after a thunderstorm. The effect of electricity on the air is to enable nitrogen to unite in a chemical combination with oxygen, and thereby become reduced to nitrous acid.

With this knowledge Charles S. Bradley and D. R. Lovejoy have set to work and accomplished much toward the desired goal. After many experiments, they have succeeded at their plant at Niagara Falls in "fixing" nitrogen. The process consists of the productioon of a large number of electric arcs, or flames, in a confined space, through which a regulated amount of air to be burned is passed from time to time. This air emerges from their apparatus laden with nitric oxides and peroxides, as the result of the combustion, and is ready for collection and treatment.

Many difficulties beset the path of the scientists. An extremely long spark was necessary in order to burn the air. It was found that static electricity—obtained from friction on glass — was not powerful enough to supply the arc desired. The great power of Niagara was turned to their use and fair success resulted.

MACHINERY FOR PRODUCING NITROGEN OPERATED BY NIAGARA FALLS WATER-POWER.

The device at last invented consists of a big box of metal six feet high and three feet in diameter. Within this box is a revolving cylinder or hollow shaft. There are openings in the box to admit air and to circulate it, and around its walls are

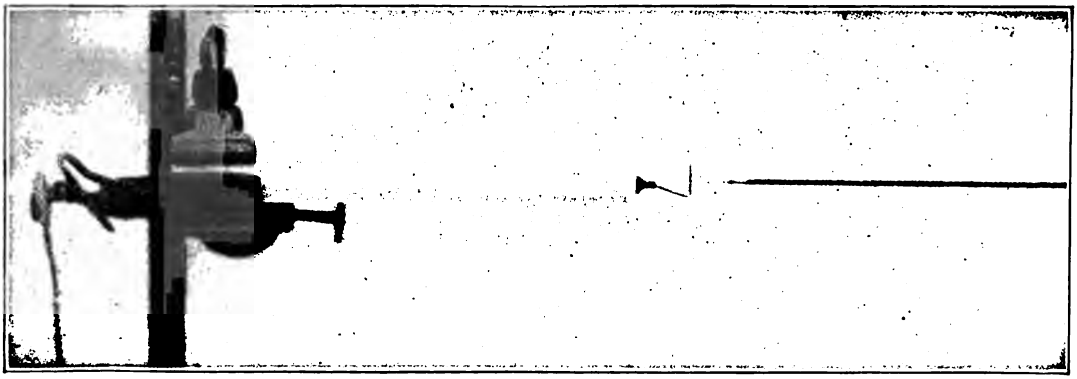


EIGHT-INCH 10,000-VOLT ARCS BURNING THE AIR.

fixed electrical contact points for the arcs, arranged in six rows of 23 points each. The negative pole of a 10,000-volt dynamo circuit is connected with the revolving hollow cylinder, which has contact projections or fingers to touch the other contact points.

The affair is set in motion, whirling at a great rate; the arcs are formed and are broken rapidly, causing a constant stream of electrical fire, and the air is "burned up." A motor at the top of the box drives the cylinder at a speed of 300 to 500 revolutions a minute and air is forced through it at the rate of five cubic feet per arc contact, per hour. The air leaves the treatment loaded with 2½ per cent of oxides of nitrogen. At the bottom of the chamber are pockets to catch the decomposed air and thence pipes lead away which carry the air and its gases to an absorption tower, where the process is completed.

These gases when brought into contact with caustic potash, form saltpeter; with caustic soda, they form nitrate of soda. The effects expected to be obtained will work to fertilize the wheat lands of the world. Already nitrate of soda is being used to strengthen land properties. It has been found from experiments that land bearing 12 bushels of wheat to the acre, by



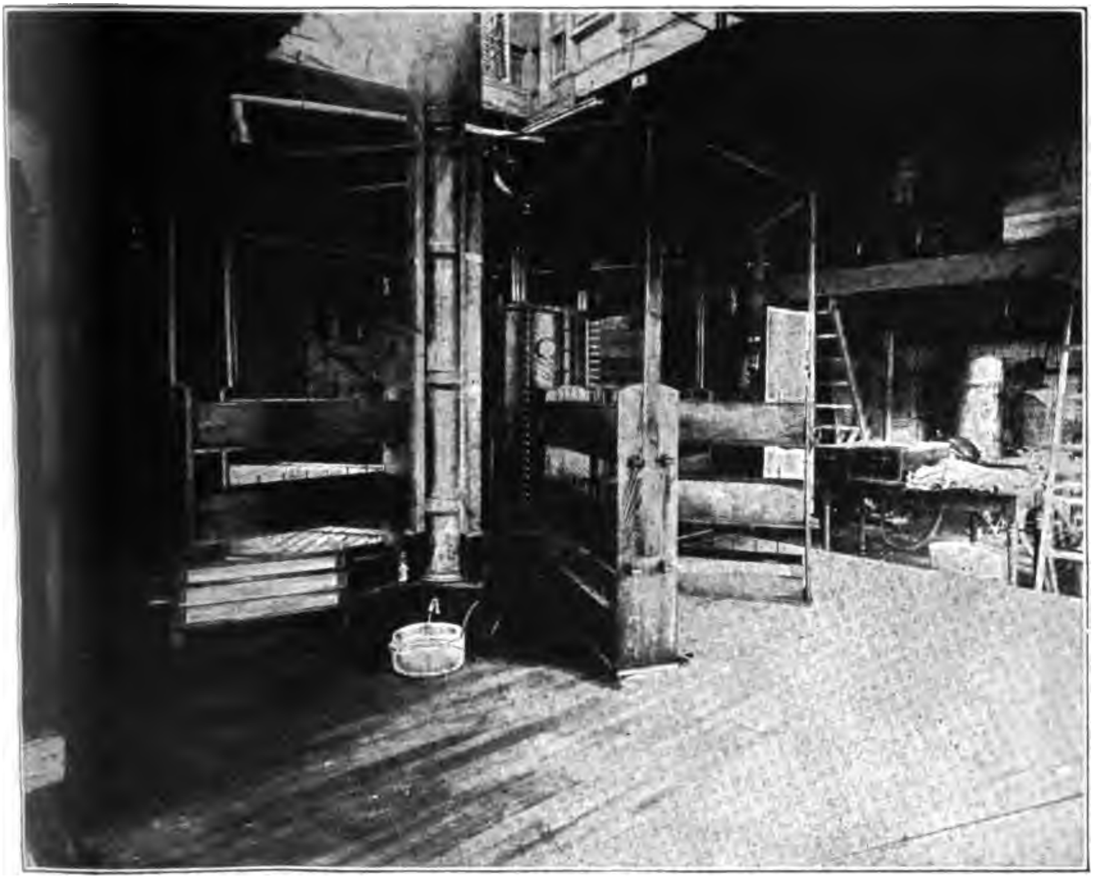
VIEW SHOWING TERMINALS USED FOR ARCING AND BURNING THE AIR IN CHAMBER.

the nitrate of soda treatment, has produced 36 bushels an acre.

SCIENCE WILL GIVE BREAD TO ALL.

If this proportionate increase of production holds good in the course of future experimentations, and there seems to be no reason to doubt that such will be the result, the immense wheat-bearing area of the United States, aside from the stimulated growth in other parts of the world, will furnish adequate material for supplying "the staff of life" to generations untold.

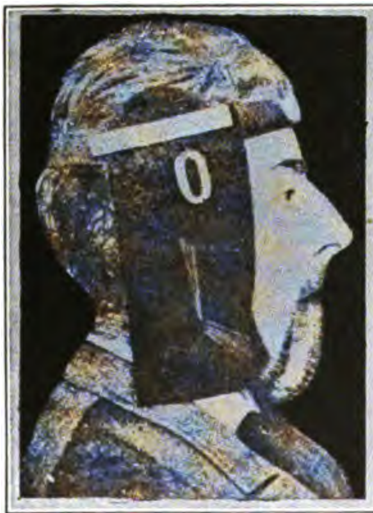
Thus science will be found to have responded once more to the needs of humanity in removing the cause of the grave apprehensions which so seriously impressed the mind of Sir William Crookes.



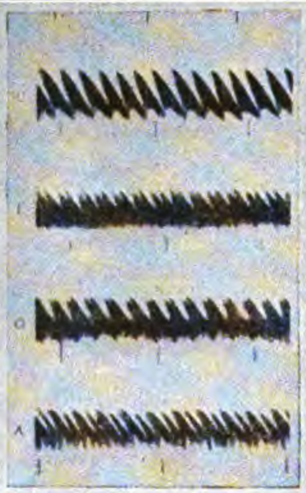
CHAMBER MOUNTED WITH ARCS.

SNAP-SHOTS OF THE HUMAN VOICE

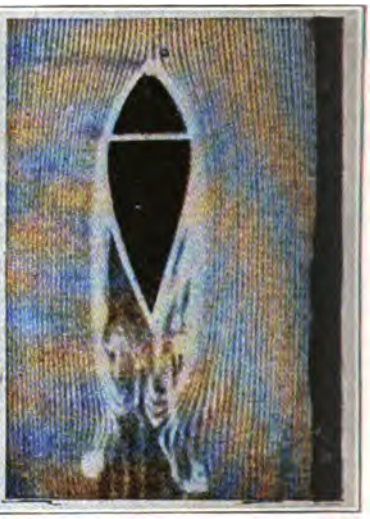
A French scientist, M. Marage, has invented a process by means of which it is now possible to photograph the human voice. The actual vibrations of the air, made in speaking the vowel sounds, can be recorded and made visible by an ingenious use of chronophotography, or the analyzing of motions by means of instantaneous photograhps. Every one is familiar with an opposite and synthetic use of chronophotography,—the presenting of animated views of moving objects by means of the kinetoscope.



CHRONOPHOTOGRAPH OF THE MOVEMENTS OF THE JAW.



HOW THE VOICE LOOKS IN FORMING SOME OF THE VOWEL SOUNDS.



PHOTOGRAPH OF AIR CURRENTS PASSING A CURVED OBJECT.

M. Marage's scheme may be described as follows: the vibrations of the air set in motion by the voice are made to act upon the flames of acetylene gas, issuing from specially prepared burners. The flames, vibrating in unison with the sound waves, throw their images into a revolving mirror, which dissociates and causes them to appear in various forms, according to the sound. By means of the acetylene flames, which are photogenic, the vibrations are recorded on a ribbon of sensitized paper.

It has been found possible also to photograph the various functional movements of the body. Thus the motions of the lower jaw in the act of opening the mouth may be represented, as well as the movements of the ribs in respiration. Another ingenious use of chronophotography makes it possible to reproduce in visible form the action of air currents in their passage around an obstruction, as shown in one of the accompanying illustrations.

SAVING SHIPS AND LIFE AT SEA

If one were able to look upon the many wrecks that are strewn upon the bed of the oceans and lakes, he would readily comprehend the value of the numerous devices that find their way to marine bureaus and patent offices, to prevent such maritime disasters. In 23 wrecks, alone, in the last century, nearly 8,000 lives were lost. A map of the Atlantic coast-line of the United States shows places where hundreds of good ships went down with all on board. In the old days when only the hardy mariner traversed the seas, the loss of life was great. To-day, however, when the whole of mankind is inclined toward globe-trotting, and when every precaution is taken to avoid calamity, the destruction of life and property is truly appalling.

Naturally, scientists and inventors have been at work to solve the question of preventing wrecks. The result has been gratifying in the extreme, and one may travel generally with a very reasonable degree of safety. But, with further research, greater improvements in precautionary methods and devices will result.

MINOT'S LEDGE LIGHTHOUSE.
The most expensive beacon on the Eastern seaboard.

THE HYDROGRAPHIC OFFICE.

Of prime importance is the protective system of the Hydrographic Office in Washington, and its branches. Here experts study the currents of the oceans, rivers and lakes, plat and chart the spots where danger lies, and advise mariners of their discoveries. In conjunction with the weather bureau, warnings against winds, hurricanes and storms are given. One of the methods applied to rough seas is the old and familiar one, still in vogue, of pouring oil on the water. Many devices have been arranged to do this effectually, and every ship is now equipped with some barrel-shaped machine for letting oil slowly seep out to quiet the angry waves.

THE LIGHTHOUSE.

Each year is adding to the number of lighthouses erected on rocky, coasts and reefs. These houses are equipped with the most modern apparatus for warning ships at sea. Great lamps revolve in their high turrets in the lighthouses, aided by powerful prismatic lenses and brilliant reflectors, and sending out their light for many miles. Lightships also are anchored in dangerous places, and send forth their warnings. In many shallow waters, the bell-buoy tolls out its incessant alarm and at night, flares its warning beacon.

Collisions at sea and their accompanying disasters have caused learned men to study how to foretell the approach of dangerous objects. Often, in a fog, an iceberg or another vessel is encountered. The devices invented to prevent this are many. Wireless telegraphy is of great service. Where two vessels are equipped with the Marconi system, it is possible to catch signals many miles away, and to avoid the same patch in the sea. But this method has not come into general use. Moreover, it would not detect the presence of an iceberg. Consequently an instrument known as the thermopile, or heat detector, has come into use, in various shapes and kinds.

THE ICEBERG.

It is well known that an iceberg greatly chills the water in its vicinity. Similarly, a vessel with great steam-boilers sends out heat. If it is possible to know the temperature of the water in which one's vessel is floating, and to detect some sudden change, either of heat or cold, it is easy to avoid a possible collision. Instruments have been made that are so delicate that they can detect the heat of a candle a quarter of a mile away.

THE THERMOPILE.

The thermopile in use by ship masters is made up of a galvanometer for registering an electric current, and two or more wires of different degrees of sensitiveness when subjected to heat or cold. Some of these different wires are made of copper, German silver, bismuth, antimony, or selenium. These metals are arranged to hang over a ship's side in such a manner as to feel a change in the temperature of the water. If an iceberg is near, the chill in the water will be noted, the current sent to the galvanometer, and a bell will be rung. If a steamer is near another bell will ring, denoting the approach of a heated object.

Admiral Makaroff, of the Russian navy, has perfected a thermopile which is located in the keel of vessels. It consists of a tube so arranged that the water of the sea may run through it. The thermopile proper is suspended in this water, and if the temperature suddenly changes a danger bell is rung in the pilot house.

Means have been employed to some extent for transmitting warning waves through water. It is well known that water is a great conductor of sound. Divers can easily distinguish the throbbing of a steamer's propeller, or paddle wheels, a mile, or more, away. Work has been done on devices to be placed in the keel of a vessel, consisting of a sensitive diaphragm which will record noises in the water.

Another instrument used to detect sound for live-saving purposes, consists of an immense hood connected with a funnel, from which lead rubber tubes, adjusted to the listener's ears. This instrument can be revolved in any direction, and so sentive is it that distant noises not otherwise audible may be detected. More than this, there is a compass attached to the instrument, and arranged so that it will show the direction of the warning sound.

TYPICAL LIGHTHOUSE AND TENDER.

Possibly the greatest benefit to sailors would be some means for dispersing fogs, and experiments have been made which, ere long, will probably result in such a discovery. Some scientists have been at work on the theory that the moisture in a fog may be condensed by an electrical discharge. To a small degree, this has proved effective, Professor Oliver Lodge, of Liverpool, by means of electrical discharge. cleared a room of thick turpentine smoke and a reservoir, of magnesium smoke In announcing his researches before the British Association for the Advancement of Science, he advocated using the donkey engines on board ships, to generate electricity, to be discharged from poles on the masts.

The means of saving life in wrecks are being improved. Each year, new devices are invented, such as automatic davits for letting down lifeboats, etc.

THE LIFE BUOY.

A new life-buoy has been perfected which is so arranged that water is allowed to leak in through a crack and mix with a powder (calcic phosphide). When the buoy is in the water this powder ignites, producing a bright flame which runs out through a tube a foot or so above the water, and, for an hour or so, is visible many miles away. Another sort of buoy has a lighting device and also the means of carrying food and drink.

Besides all these devices for preventing wrecks, there is ever a watchful eye on the lookout to protect the stray mariner from death, after his ship is wrecked. The United States Life Saving Service is a credit to the nation. Its members, like their great brother order of life and property savers, the firemen, accomplish much in the saving of life that would be impossible, were it not for the great hardship these brave men undergo.

Along the coasts of oceans and great lakes, extend lines of life saving stations, manned by hardy crews whose business it is to watch out for vessels in danger, or already wrecked. Patrols of men walk the beaches, or spy out upon the waters from their watch stations, for a sign of distress.

After the distress signal has been sighted, everything in the station is bustle. It may be that a big ship has crashed upon a reef or sand-bar, and is pounding herself to pieces in the angry waves. If the ship cannot be reached from land, the life-savers must clamber into their big boats and pull away to the rescue. Often the savers, themselves, go down before the fury of the tempest, in trying to rescue their fellow men. But, more often, are the sailors, chilled through by the icy waves, brought safe to shore.

THE BREECHES BUOY.

If the use of a life-boat is impracticable, resort may be had to the breeches buoy. The savers are equipped with a coast gun—a sort of short cannon—in which is loaded an iron pin fastened to a life line. The gun is fired off, the pin hurtles over the ship in distress, and the line is hauled in by the weary sailors until a block and tackle are taken on board. This tackle is attached to the mast, a rope is run through it to shore, and down this rope travels a pulley, to which is attached a heavy pair of leather breeches. The sailor gets into this buoy, and is drawn safely through the waves to shore. There are many methods besides these, used by life savers, but these are the most important and most commonly used. Naturally, a life saving station is equipped with the latest kinds of improved boats, etc. The life boat now in most common use is fitted in the bottom with self- acting valves, which empty it of any water that may dash over the sides. So perfect are these boats, that in practice tests, the savers frequently tip them over completely, and they will right themselves and drain off all the water.

THE MINOT'S LEDGE BEACON.

Among the Government lighthouses which serve their beneficent purpose on dangerous coasts, that at Minot's Ledge, Boston Harbor, is perhaps the most noteworthy. It has been twice destroyed, once in 1842 by a drifting ship striking it in a storm, and again in 1863, when an historical hurricane swept the New England coast. The second house was supported on steel piles 13 inches in diameter, and after the light went out when the storm was at its worst, the huge beams were found twisted like twine, leaving no other evidence of the tragedy which cost the lives of three persons living there. The present structure is built of masonry and cement and promises to last for centuries.

WIRELESS FOR SAFETY AT SEA.

When a burning steamer, the Volturno, imperiled at sea, was able to summon to its aid by wireless message no fewer than eleven steamers, indisputable proof was given of the priceless value of this means of communication in the saving of life on sea-going ships. Marconi's great invention then clearly established its position as one of the most merciful aids to the saving of human life in all the history of invention.

THE MARCONI WIRELESS STATION ON A STEAMER.
No important passenger ship is now without wireless apparatus.

It was not surprising, therefore, that the United States government recommended to the International Conference on Safety at Sea which met in London late in 1913, that very stringent rules for the installation of wireless outfits on all ocean-going vessels be generally adopted.

PHOTOGRAPHY AND THE USE OF THE CAMERA

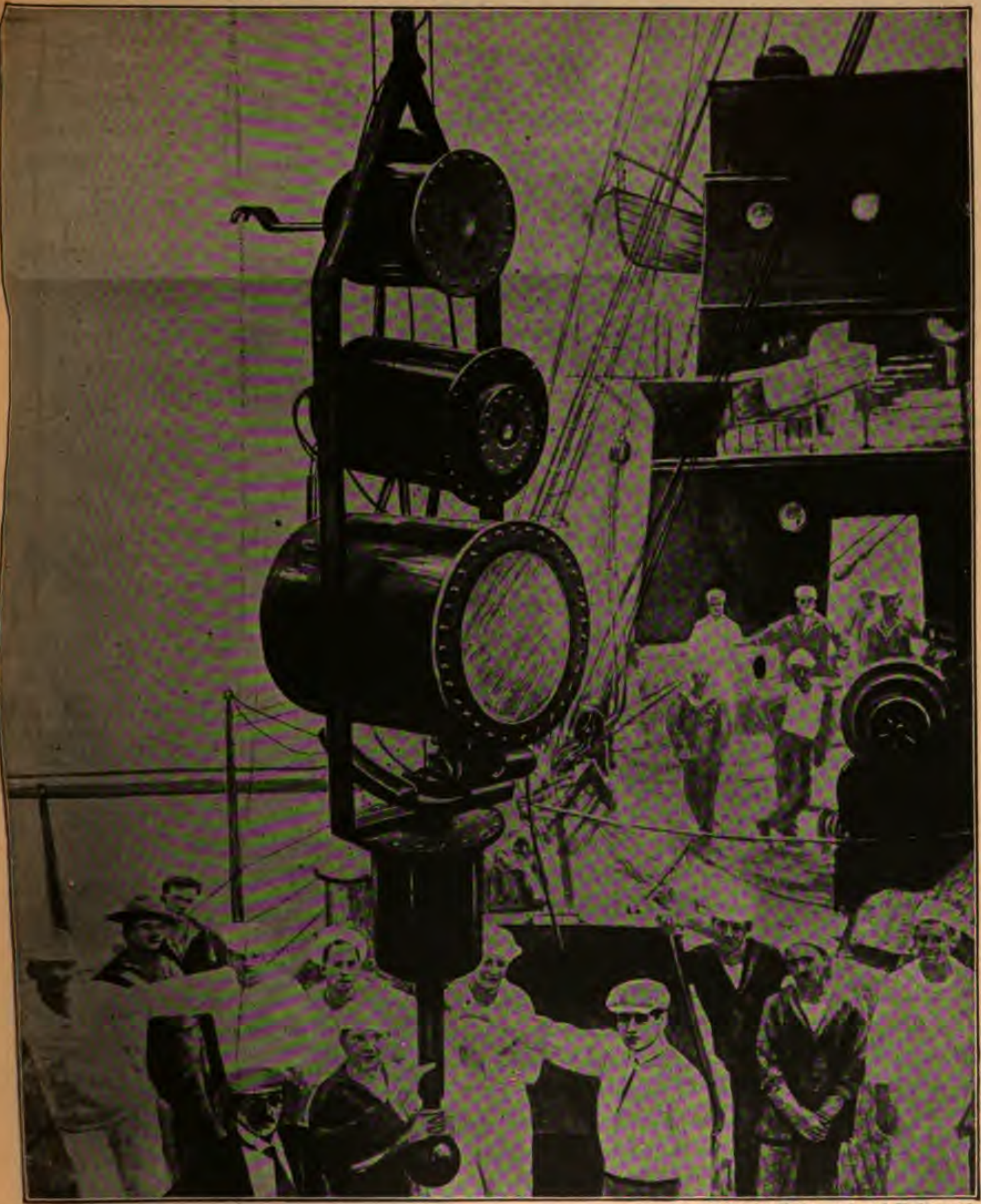
Nearly every person is familiar with the photographer's studio and has had his or her picture taken many times. To most of them the mysteries of the dark room have been explained and many now own snap-shot cameras themselves with which they can take pictures. On the other hand, even those who are amateurs and have taken photographs realize the great strides being made in the science of photography, and what the result of the progress of the art means to the world. It can be imagined readily enough that new kinds of photographic plates are being manufactured which will allow much more rapid exposure of moving objects. The development in the manufacture of sensitive paper upon which photographs are made has also been so great that, nowadays, nature and life are portrayed with remarkable accuracy. Let us look, however, at some of the remarkable things done in the realm of photography.

THE TELEPHOTOGRAPH.

The telephotograph, as its name signifies, is a picture of an object taken from a distance. Most cameras are equipped only to take pictures of objects near at hand. When far off mountains and other inaccessible objects are photographed, usually only small pictures with indistinct details are the result. To-day, however, it is possible to catch pictures as deftly and in as distinct detail as one can view an object from afar through a telescope. The device which permits telephotography is called a rack-and-pinion lens tube in which are fitted two lenses. One of these is the far-seer or negative lens and is the one that does the magnifying, while the other ordinary lens in front of the far-seeing concave lens does the photographing. Work may be done with this combination in the field, all that is necessary being to adjust the rack and pinion to get a good focus. One of the drawbacks to this kind of photography is that because of the smaller range a magnified picture covers, naturally less light is

By courtesy of "Lawrence" Photographer.

READY TO ASCEND TO MAKE AN ACTUAL BIRD'S-EYE VIEW.



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A SUBMARINE CAMERA.

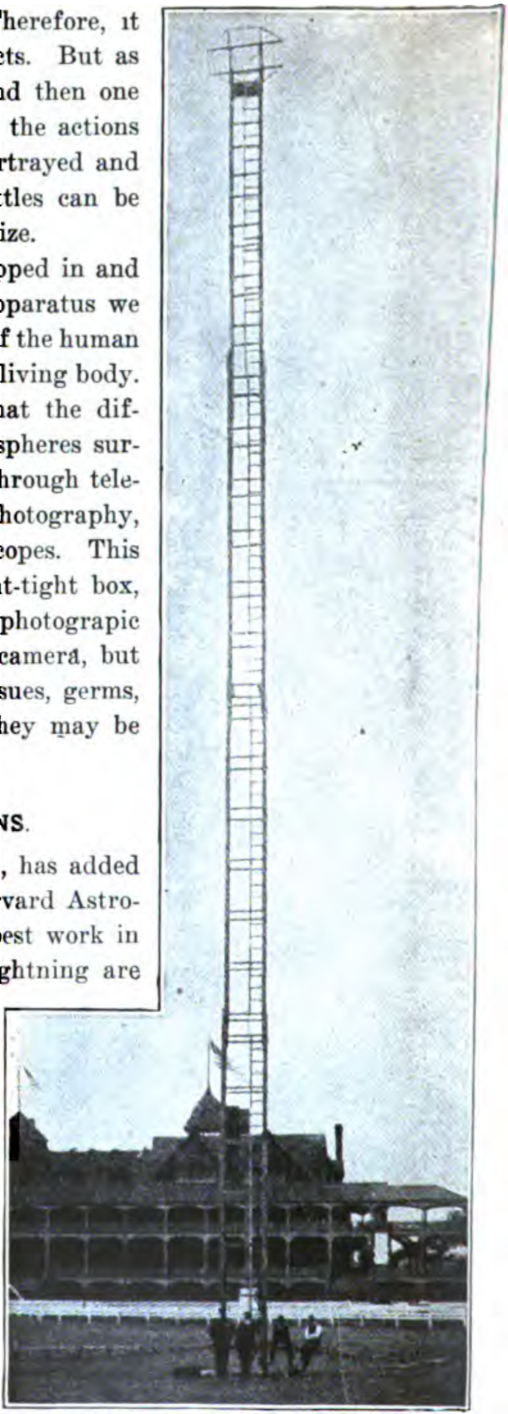
It operates automatically and takes either moving or still views, at a depth as great as 1,000 feet. It produces 1,000,000 candle power and is capable of taking 6,000 single pictures without being taken out of the water, and each view can be taken three times at different focuses so that near and more distant objects can be clearly represented. As it turns on a vertical axis the entire surroundings can be depicted. It will certainly be of great service in wrecking operations, and doubtless results of great scientific value will be obtained.

admitted and the exposure has to be longer. Therefore, it seriously retards taking pictures of moving objects. But as time goes on, the apparatus will be perfected and then one may attach it to a cinematograph camera. Then the actions of wild animals miles away can be accurately portrayed and studied. Birds can be caught in flight and battles can be photographed from afar and reproduced in life size.

In delicate scientific work photography has stepped in and done marvelous things. By use of the X-ray apparatus we are enabled to take pictures, or "shadowgraphs," of the human heart, ribs, stomach and other organs through the living body. In astronomy, we have been able to discover what the different stars are made of and what kind of atmospheres surround them. This kind of photography is done through telescopes proper, and is a great deal like micro-photography, which consists in taking pictures through microscopes. This latter method consists simply in attaching a light-tight box, with a very long bellows, to a microscope and photograpic lens. This is a good deal like a telephotograph camera, but is used mainly for taking pictures of diseased tissues, germs, and minute animal and vegetable life, so that they may be studied afterwards at leisure.

TAKING PICTURES OF THE HEAVENS.

Taking pictures of lightning, stars, comets, etc., has added much to the knowledge of the world. At the Harvard Astronomical Observatory in Cambridge some of the best work in this line has been done. The photographs of lightning are taken much the same as one takes snap-shots, only the camera is much bigger; in fact, it is a great telescope itself, with a plateholder and sensitive plate attached at the small end—the eye-piece. In taking a picture of a flash of lightning great pains must be taken for one never knows just where to catch the lightning. Besides there is generally rain falling when one wants to take such a picture, and this tends to spoil the scientific value of the picture, because the rain drops act as tiny prisms and break up the light. One of the best experiments in this direction has been in photographing the spectra of stars and lightning.



By courtesy of "Lawrence" Photographer.

PHOTOGRAPHIC TOWER
USED TO MAKE BIRD'S-EYE VIEW.

THE SPECTRUM.

A word about the spectrum. Heat anything to the point where it gives out light, and then pass a ray of this light through a prism of glass and a line of colored bands will result, ranging in some cases all the way from violet through blue, green and yellow, to red. That variegated strip is the spectrum, and the different series of these bands represents the elements in the substance examined. The most familiar spectrum is, of course, that of the sun when its rays are intercepted by the prismatic drops of a passing shower and produce a rainbow. The glass prisms hung as decorations from old-fashioned lamps also make spectra. But a photograph does not produce colors, and lightning will not stay quiet to have its picture taken. How, then, can a spectrum of lightning be photographed? At the big end of the telescope a prism is attached, and by adjusting the camera at an angle, the refraction or turning aside of the rays after they have entered the prism is thrown into the telescope. After a number of pictures have been taken, one or two may be of value. These plates are developed and the lines of the spectrum of the lightning will show. Here comes another difficulty, however, for yellow and red are not colors that can be absorbed readily by the photographic plate. Therefore the pictures of the spectrum will show only different degrees of blackness and whiteness, marked by little waves as the colors affected the plate. But these are still of great value, for, by comparing them with pictures of spectra of known lights, great discoveries have been made.

ELECTROGRAPHS.

Some of the peculiar properties of electricity have been discovered by taking electrographs, or pictures of electric sparks. This is done by interposing a photographic plate, wrapped in a dark envelope, between two poles of a static electrical machine. The spark which jumps from the pole strikes the envelope, penetrates it, and leaps off the plate to the other pole. This exposes the plate and gives a picture. By studying these pictures scientists are enabled to learn much about the laws governing electricity. One already arrived at is that it follows the line of least resistance, and that often it takes divergent paths in traveling.

USE OF THE CAMERA.

A photograph is not always a picture. The mere regard for the mechanism and chemistry of photography does not insure success in the art, for the results may be a composition far from pleasing to the eye. For instance, a straight front view of the end view of a building is always disagreeable because there can be no perspective.

In photographing anything with height, breadth and depth, all the proportions should appear. A view from one corner is preferable to any other, although the best effect is seldom obtained by placing the camera directly opposite a corner. The photograph should show, if possible, more of the front than the end. Sometimes, where a street is very narrow, it is impossible to find the ideal position for a camera and in such cases the photographer is obliged to be content with the nearest possible approach to that point. The position of the camera and its height with regard to the object to be photographed are of the utmost importance.

With regard to height, the choicest position is the level of the eyes. When, however, the object to be delineated is so high that the only position of the camera from which the photograph can be taken at the height of the eyes, is so far away that half or nearly half the plate is lost in foreground, it may be preferable to make the exposure from a position nearly half as high as the object. By this means the distance necessary to include the whole figure may be reduced nearly half, and the size of the object in the photograph may be nearly doubled. This is nearly always necessary with tall subjects, when a fixed-focus camera without a rising front or a swing back is employed.

If, however, no place except the ground is available for the camera, the picture will be greatly improved, although considerably reduced in size, by cutting away from two-thirds to three-fourths of the foreground before mounting the print. In no case should the camera be above the center of the height of a building or tower. The picture improves the nearer the camera is brought to the height of the eyes, provided, of course, the whole of the structure is included. Next in importance to the position of the camera with regard to perspective and height, is its relation to light and shadow. A picture in which everything seen is brightly lighted, is rarely pleasing, and one in which the whole view is in shadow is even less attractive. Flatness in a picture is due to want of contrast; that is, to the absence of high lights in a shadow picture, or to that of shadows in one made from a position directly between the source of light and the object. In nearly all satisfactory photographs, including groups and portraits, there is a good blending of light and shade in considerable masses. A photograph mottled all over with shadows and flecks of light in nearly equal proportions is almost as objectionable as one that is light, or a shade flat.

The more nearly the masses of shadow assume rough triangular forms, the better the picture; and the larger the triangles, so one, either of light or shadow, does not exceed one-half to two-thirds of the area of the plate, the more pleasing the effect. This is limited, of course, to buildings and landscapes. In taking a building it is best to have the front lighted, and the end in shadow. The perspective, of course, if the camera is placed as suggested, makes each side a triangle more or less regular and complete, according to the style of the architecture.

Light and shadow in a picture are not wholly dependent upon sunshine and shadow. Dark objects serve the same purpose as shadows. A tree in foliage is always dark. A mass of foliage, therefore, is as good—often better—in balancing a landscape than an actual shady side to some object; and a picture with a high, green hill or mass of foliage sloping down from one corner to a point at or beyond the middle, is always picturesque. Water and sky are nearly always very light, and when they furnish triangles, make the picture complete. On the beach, a dark building, a pile of rock or wreckage, or even a group of people near enough to the camera almost to fill one end of the plate, enhances the beauty of the picture. If a group of people is utilized for the purpose, care should be exercised to have them in dark clothing. White attire defeats the principal purpose of utilizing a group in such a case. The best view of a crowd can be secured from a position overlooking it. A portrait should not be made with the camera very much below the chin of the subject. The level of the middle of the body greatly exaggerates the height of a person. Below is given an illustration of black and white attire.

A FAMILY GROUP.

A MILITARY ROCKET CAMERA

A photographic camera that can be shot into the sky to take pictures of an enemy's position is a modern device that has been successfully used by an engineer of Dresden, Germany. The camera is contained in the conical cap of a large rocket. The cylindrical head of the rocket contains a charge of powder. The shaft 20 feet long prevents the rocket from overturning in the air, while at its rear or lower end there are crossed vanes which prevent rotation about the axis of the rocket during its flight, and for this purpose it is also provided with a gyrostat which comes into operation automatically when the rocket is fired. The exposure is made by an electro-pneumatic device, operated by a small galvanic battery. It acts at the moment when the rocket attains the highest point of its flight.

Immediately after the exposure a parachute, which is attached to the camera and packed between it and the rocket head, opens, and the camera is detached from the rocket, but remains connected with it by a cord about 33 feet long. The result is that the whole apparatus falls slowly until the rocket strikes the ground.

WONDERFUL MOVING PICTURES

Of recent years, great advances have been made in the art of perfecting magic lanterns. The greatest invention in this line and the one productive of the weirdest results is the device for reproducing, in picture form, the movements of life, so naturally that one would believe the living objects portrayed were passing in review on the lantern screen.

The first step in the discovery of the principle which underlies moving pictures was the invention of the zeotrope. This consisted of a disk, on the back of which were painted a number of pictures of some animal in various stages of motion. Underneath each picture was a narrow slit. The disk was a toy which was intended to be impaled on a pin so that it could be whirled around. By holding the picture side of the zeotrope near a mirror, and by looking through the slits as the disk was spun around, one could see a rapid succession of pictures in the mirror, the animal apparently moving forward by jumps. Inasmuch as the pictures were painted from imaginary positions which were not always true to life, the method of movement sometimes showed very odd phases.

Gradually, the idea of portraying motion grew with inventors, and a principle, in which great development was involved, came to light. That was the method of passing a strip of pictures between the light and the lens of the lantern, and by the use of a light shutter, to close the lens from the light for an instant, between each picture. The most perfect cinematographs, or moving picture machines, now use this method of jerking pictures through a lantern, letting them pause momentarily, and then closing off the light and moving on to the next picture. The result is a continuous picture of the objects in motion, giving the effect of the progression.

When this idea was evolved the next important thing to be discovered was a method for getting exact pictures of things in motion. One man tried the scheme of standing a number of photograph cameras in a row, and taking numerous pictures of the animal, or object, as it moved by. The result was a great improvement, but naturally the cameras could not be placed closely enough together or operated rapidly enough to catch the motions accurately. Then came Edison with his kinetoscope, by which he took instantaneous pictures on long strips of film, at the rate of about 30 photographs in a second. Thenceforth the moving picture problem was comparatively easy.

In this method, long strips of sensitive gelatine films are prepared after the manner of any photographic plate. They are very narrow, are from 70 to 600 feet long, and are wound on spools. These films are run through a photograph camera specially adapted for the work. It is arranged so that only a tiny bit of the film is exposed at the focal point at a time. Then a shutter stops off the light, the film moves on an inch and is exposed, only to be shut off from

the light again, and moved on once more. This is done very rapidly, in fact, so rapidly that about a thousand pictures can be taken in a minute, thus depicting marvelously the actions of moving beings and things.

The next thing to be done was to devise a magic lantern arrangement that would practically duplicate the action of the shutter device on the camera, and also to develop the photographs taken on such long strips, without marring them. Several methods have been adopted for this latter work. Sometimes, the yards and yards of gelatine are wound on windlasses and run through the enveloping chemicals bit by bit. At other times, the strips are wound on pegs and the whole affair immersed at one time. It must be remembered that the pictures taken are negatives,—that is, everything naturally light shows black in the negative, and vice versa. Therefore, pictures must be made that will show on the picture screen in their proper tones. In order to do this, other strips of the sensitive film are placed over the negatives and exposed and developed. When these last strips are dried they are run through the cinematograph machine, but with a very powerful light behind them. The film is unwound and by means of the same shutter device on the camera, the light is turned on and off as the picture is behind the lens or moving into position. The lens throws the picture in enlarged form on the screen placed on the wall. Because of a phenomenon of optics called persistence of vision, the spectator sees the picture for a brief instant after the light is shut off. Thus when the strip is run through, the series of pictures appears as one picture in constantly changing shapes, giving an imitation of life.

DEVELOPMENT OF THIS INDUSTRY.

The moving picture has effected a complete transformation in the theatrical world. The daily amusements of the multitude have been completely changed, and for the first time since the days of Shakespeare the dramatic theater, the stage of the spoken word and the illusory scene, finds itself outrivaled in popularity with the masses, who find in "the movies" a cheap and satisfying form of entertainment. Thousands of theaters are now devoted to moving pictures in this country, their annual revenue amounting to a sum truly fabulous when it is remembered that the prevailing prices of admission are generally five or ten cents. Great film companies and enterprising individual producers now scour the whole world for scenes with which to stage motion-picture plays, and the greatest dramatic artists of the American and European stages have enacted their most successful roles before the moving-picture camera for reproduction in the "movie" theaters of a thousand cities and small towns. To-day there is scarcely an American village so small that it does not support at least one moving-picture theater; while the production of films for exhibition is so great and varied, and the competition so keen, that most of the larger cities of the country have established municipal censorship, under which all new films proposed for public exhibition are first submitted to a board of censors for approval.

EDUCATIONAL VALUE OF MOVING PICTURES.

The educational value and possibilities of the moving picture are generally recognized. History and travel are visualized by its means and the obscure processes of nature are explained and analyzed. Methods of manufacture and production are made clear and useful instruction may be conveyed in the most interesting manner. As a factor in education, science and trade, and in recording current history, the motion picture is still in the early stages of its development and usefulness; and in its application to amusement in its highest form there is rare promise of a great and brilliant future.

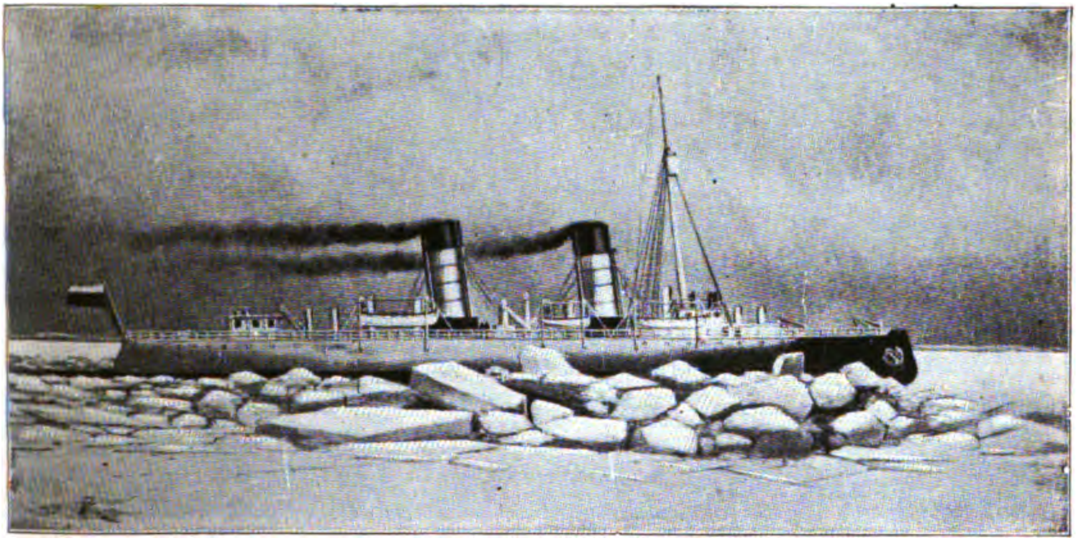
THE KINETOSCOPE, USED IN MAKING MOVING PICTURES.

MOVING PICTURE USED BY THE DEPARTMENT OF AGRICULTURE.

The Department of Agriculture maintains an effective motion-picture department. The agents of this department use this means to illustrate at farmers' institutes the results of their work. And in remote sections inventions have been perfected by which electricity for this purpose is generated by use of automobile motors. The Bureau of Animal Industry, for instance, used moving pictures to explain about various processes, such as method of fighting ticks by bathing. The Good Roads Bureau uses the pictures extensively, also the Forestry Bureau, showing detail of their work.

MOVING-PICTURE LABORATORIES.

Film preparation is on such an important scale that great corporations have built special towns where every facility is at hand to produce films to give acceptable moving-picture representation of scenarios or plays which they bring out. For instance, Universal City in California is given over entirely to the production of moving pictures. Animals are often needed, so they have the finest privately owned zoo in the world. All animals of any importance are kept. They have an Indian village of genuine red men, cowboy barracks, and soldiers' quarters. In the architecture of the city they contrive to have specimens of all kinds, everything, in fact, to give reality to their scenes, and there the actors and actresses rehearse their parts, that is to say, they pose and go through the motions, or perform actions suitable for the scenes they are illustrating. The reflective student sees in motion pictures a revival on an immense scale of the pantomime performance which delighted the ancient Greeks and Romans and indeed was a great favorite down to recent centuries, in which no words were spoken, but dancing and acting alone were the means employed to delight and instruct the audience.



DIFFICULTIES OF POLAR EXPLORATION.

FINAL TRIUMPH OF POLAR EXPLORATION

Wonderful triumphs in the fields of inventive genius, and pure science; in the fields of war and peace alike are not the only directions in which the efforts of man have been crowned with success. At last all sections of the earth have been visited by civilized men.

DISCOVERY OF THE NORTH POLE.

April 6, 1909, Commander Robert E. Peary reached the North Pole, and thus brought to a successful conclusion efforts initiated three centuries earlier by that illustrious explorer, Henry Hudson. After various fitful attempts, exploring work in search of the North Pole was begun in earnest in the closing decades of the nineteenth century. Commander Peary left on his final and successful expedition in 1908, spent the winter at Cape Sheridan, and began the final dash for the Pole February 15, 1909. That was in the heart of winter, but it was the only chance for success, for at that time the ocean for hundreds of miles around the pole is frozen over. We can scarcely realize the difficulties and dangers of this march. It involved a trip of some hundreds of miles over the frozen surface of an unknown sea. The ice was liable to be broken up at any moment, and the surface ice was extremely rough, rising and falling in a confused mass of hummocks. But only one life was lost on the trip. No results of great scientific value have resulted from this discovery. We knew, however, that an ocean two miles and more in depth covers the area around the North Pole, and it is a satisfaction to know that the farthest point north has finally been reached.

DISCOVERIES OF THE SOUTH POLE.

Captain Roald Amundsen of the Norwegian Navy reached the South Pole December 16, 1911. He found it was situated on an elevated plateau, 11,000 feet above the level of the sea. He erected a small tent at the place, called it Polheim, and named the elevated plateau "King Haakon VII Plateau" in honor of the King of Norway. His trip had, of course, been attended with great difficulties. They knew, however, that beneath their feet was firm land and not the water of an uncertain sea. But there were vast snowy plains to traverse, glaciers to surmount, with all the dangers of hidden crevasses, then there were mountain ranges with more than Alpine difficulties to be mastered. As showing the dangers of the quest, we might mention that Captain R. F. Scott of the British expedition also reached the South Pole just a month later. He found Amundsen's tent and records and knew he had been preceded at the pole. But he himself and a small party remaining with him perished on his return trip. Here again no practical and valuable results followed the discovery. But at last the poles have been reached. We know the conditions there prevalent. It is interesting for the thoughtful student to consider the difference in the surroundings of the two poles. A high elevated continental expanse around the one, ocean depths around the other. Ages hence, different climatic conditions may prevail, and fertile plains may replace the sterile wastes of the one, and temperate waters roll over the other. Whether such mutations will take place we do not know, but we do know that ages past warm and even tropical conditions existed around the North Pole. According to some of our scholars, such mutations follow a cyclic law, requiring many thousands of years to complete.

THE END OF DISCOVERIES.

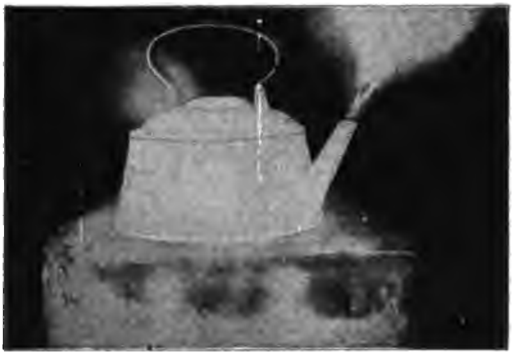
With the discovery of the poles we come to the end of the Age of Discovery, initiated by Columbus late in the fifteenth century. There are remaining no sections of the earth that have not been visited by man. The thoughtful student should reflect on the wonderful expansion of thought that has resulted from increase in knowledge of the earth. Henceforth such expansion will depend more and more on scientific discoveries and in that field there can be no limit placed on future advance.

VIOLET LIGHT USED IN HOSPITALS

Some diseases of the skin which are caused by bacteria are treated by light. Dr. Finsen, of Copenhagen, has perfected a method of concentrating violet rays of light which, when cast on diseased tissue, seemingly penerate it with bactericidal effect. He exposed a bacillus culture to bright sunshine and found that the light killed it in an hour and a half. He discovered that when the skin was full of blood the light took a longer time to penetrate. He proved this by putting a piece of sensitized paper behind a man's ear and this, after a considerable exposure, was not affected by the light. When the blood was pressed away from the ear an exposure of 20 seconds turned the paper black. Further experiments showed Dr. Finsen that blue rays of light would kill bacteria. In order, therefore, to concentrate these rays, he divided the lens, between the glasses of which he put a solution of bright blue, weak, ammoniacal copper sulphate. These lenses are attached to the skin by rubber bands. Cool water is run over the glasses to prevent the heat of the rays from blistering the skin. The weight of the glass presses the blood away from the surface and the violet rays quickly penetrate the skin and kill the germs.

ULTRA VIOLET RAYS OF LIGHT PERFORM WONDROUS CURES.

LIQUID AIR—ITS WONDERFUL POWER



LIQUID AIR BOILING ON A BLOCK OF ICE.

To Charles E. Tripler, a scientist of New York City, belongs the credit for having made liquid air familiar to the scientific world, cheapened its production, and applied it to practical commercial purposes.

It seems almost a contradiction in terms at first thought, and yet scientists have been able to liquefy not only air but many other gases, while they can also turn solids into liquid, and the resulting liquid into gases. It is all a matter of temperature and pressure.

Tripler, however, was not the pioneer in experiments. Scientists had long observed that to compress a gas into a reduced volume, raised its temperature greatly. The heat thus resulting was to be generated by the pressure applied, but experiments soon proved it was not caused by the actual increase of the heat of the whole body, but rather by the concentration of the heat of the entire mass into the smaller space.

Later experiments showed that if this gas under pressure was cooled, and then allowed to expand to its former volume, it would fall greatly in temperature, and in practice a drop of 200 degrees was obtained. In 1877, the first real headway was made by scientists in their efforts to liquefy air. The first real success in these experiments was made by Raoul Pictet, who submitted oxygen gas to a great pressure, combined with intense cold, and produced a few drops of the clear liquid that soon evaporated into the air after a few moments of violent bubbling. In 1892, there was a like success with nitrogen, the other constituent of air. About the same time Prof. Dewar, of England, performed the same experiments, and then succeeded in producing a small quantity of liquid air, or rather a sort of slush of air, water and ice. His

PACKING LIQUID AIR FOR SHIPMENT.

LIQUID AIR BOILING BY HEAT OF THE ATMOSPHERE.

experiments aroused the utmost interest among scientists, but the cost of the apparatus and processes, which amounted to $3.000 for this first ounce of liquid air, limited it to laboratory experimentation.

It was Prof. Tripler who discovered the means by which this wonderful product could be made with ease, at a cost of not more than 20 cents a gallon. Tripler's process comes as near being a practical form of the chimerical perpetual motion as can be conceived, as he utilized power generated by the liquid air itself to produce more liquid air, and as the production from a given quantity is in each instance a larger quantity, there is a constant increase of the power at command.

The apparatus for the manufacture of liquid air, in addition to the power plant, is an air compressor, and a barrel-shaped tank about 15 feet high, penetrated by a multitude of small pipes and valves, protected by felt and canvas to keep out the heat. This contrivance is so arranged that the expanding air, which constantly grows cooler, passes about the pipes containing the working material. Air is placed under a pressure of 2,500 pounds to the square inch, and cooled to about 50 degrees by being passed in pipes through running water. From there it is conveyed to the receiver through two different sets of pipe, one containing the air to be liquefied, and the other the air that does the work of liquefying, both under the same heavy pressure. By opening a tap in the receiver, the air from the latter pipe rushes up and around all the pipes in the barrel-like space, expanding, reducing the pressure, taking up the heat wherever any can be found,

DRAWING LIQUID AIR FROM THE LIQUEFIER.

growing warmer, and gradually rising to the top of the space.

While this process is in operation the air in the pipes has been gradually returning to the compresser, where it is again brought under pressure and cooled, only to be released once more in the receiver, there to absorb more heat from the confined air in the pipes. So rapid is this process that the temperature of the air goes down 100 degrees every time it is thus chilled, and it takes only fifteen minutes to produce the desired result. At the expiration of the fifteen minutes the faucet at the bottom may be opened, and the liquid air, at a temperature of 312 degrees below zero, begins to flow from the pipes.

Liquid air is of such an expanding nature that if confined it would explode. In order to preserve the product thus yielded, various devices have been prepared. One of the vessels used for carrying liquid air is a bulb of glass, which is surrounded by an outer vessel, of the same material, the two having a vacuum between them and joined by a common neck at the top. The vacuum thus produced delays the passage of heat, so that the evaporation of the liquid in the inner tube is reduced to a minimum. In a shipment of nine hours, air packed in the above manner, loses less than one-third of its bulk.

Liquid air is eleven and one-half times as powerful as compressed air, and yet it may be carried in a pasteboard box, while the heaviest steel tanks would be required to control as much energy in compressed air. In the meantime Prof. Tripler goes on experimenting with this wonderful air. Inventors of airships are seeking something that combines great power with lightness; submarine navigators want an economical motive power and air for the crews to breathe; deep-sea divers hope that some service may be rendered to their perilous profession by the use of casks of the liquid suited to their apparatus, and automobiles have been adapted to this power. By the use of liquid air, a rose may be frozen in its full form, or an egg may be made so solid that when broken, it will scatter like a powder. The surface of a frozen potato is as hard as stone and beautiful as ivory. Frozen butter may be pounded in a mortar until it is as fine as flour, and raw beefsteak will become pale and then break, like petrified wood. Mercury is frozen, and alcohol

ROSES FROZEN WITH LIQUID AIR RENDERED BRITTLE AS GLASS.

is made stringy and white by this air, and steel bars, when dipped into this liquid, may be burned as readily as a piece of dry wood.

ITS POSSIBLE USE FOR FUEL AND PROPULSION.

In the not distant future, liquid air may supplant some forms of fuel, for when mixed with any form of carbon, it burns rapidly or explodes. Thus it may be used in interior combustion engines—for instance, the gas engine.

ITS USE IN SURGERY.

The intense cold of liquid air has the same property as great heat without causing a blister. Thus, naturally, the use of liquid air in some sorts of diseases where cauterizing or burning away is necessary has shown marked success. Putrid flesh is killed and foreign growth is removed by its agency. Ulcers have been eaten out and facial erysipelas has been cured by driving away the heat from inflamed tissues through rolling a glass tube filled with liquid air over the face. Frequently it takes the place of the surgeon's knife.

By courtesy of Dr. Zeigler.
REMOVING TUMOR ATTACHED TO 5TH, 6TH and 7TH CERVICAL VERTEBRAE.
No Anesthetics Used—No Pain Experienced.

FULL RECOGNITION OF A GREAT DISCOVERY.

When, with its lightness and extreme potency, it shall be utilized in helping to solve the problem of practical aeronautics, and shall also be made to serve, with a suitable motor, in propelling submarine craft, while at the same time supply breathing air to the crew, through compression in storage tanks, then its value will be seen.

DRIVING A NAIL WITH A HAMMER MADE OF MERCURY FROZEN BY LIQUID AIR.

QUESTIONS ON THE INVENTIVE AGE.

What is an invention?

Mention some invention Mr. Edison made.

What kind of an engine do they use in automobiles? How does it differ from an airplane engine?

What is the difference between an automobile and a tank?

Who invented the first automobile?

What are the two great divisions of automobile? .

Mention some parts of the automobile mechanism?

How did the auto trucks help win the World War?

Which was the more important in war the automobile or flying machine?

Is a tractor an automobile?

What is the difference between a motorcycle and a bicycle?

Were motorcycles used in the war? How?

Explain the cannon ball submarine. What is the difference between it and a war submarine?

The steam turbine was mentioned in electricity—in what connection?

Mention some uses of pneumatic tubes.

Tell what you can of the principle employed in a phonograph. What musical insrtument utilizes it? What office machine?

Can you work a typewriter? Explain its workings.

Mention some calculating machines? What machine does your grocer use?

What is a seismograph?

We talk about "heat from the sun"—from what you have learned about electricity, what is it that really comes from the sun?

In making calcium carbide for acetylene gas, the electric furnace is used—explain such a furnace. How is the heat generated?

What is meant by "bread from the atmosphere"? We have mentioned a large plant built by the government for fixating nitrogen, where?

Mention some means of saving life at sea.

How does electricity help in such work?

What is the difference between the telephotograph and the telephotography discussed in electricity?

Describe the submarine camera.

We have described X-ray photographs, how do they differ from ordinary photographs?

Tell what you can of the spectrum. What is to photograph the spectrum of a star?

Do you enjoy moving picture shows? If so tell what you can about how they are made.

How are they made to extend agricultural knowledge?

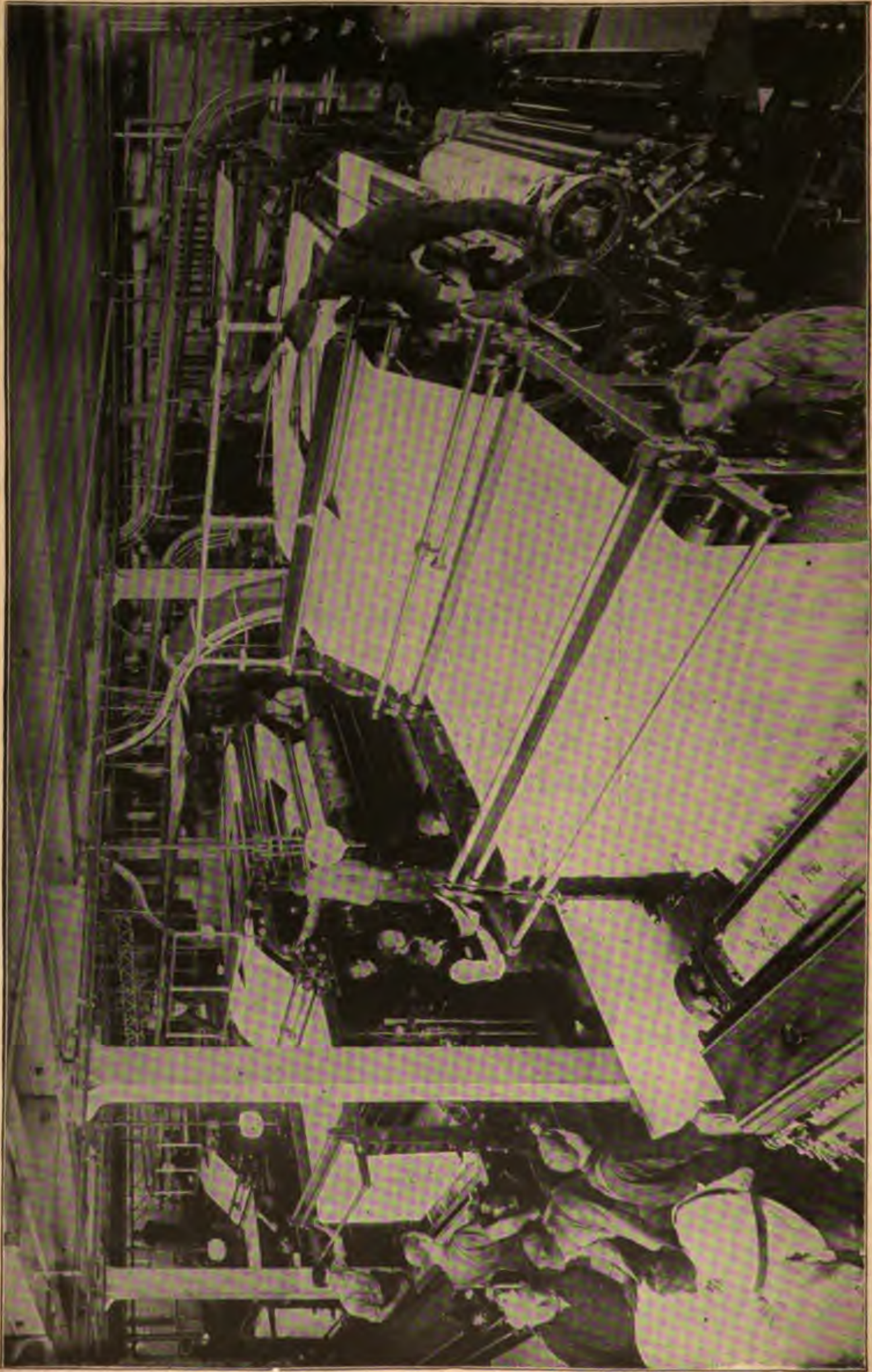
What is a moving picture laboratory?

Tell what you can about the discovery of the poles. What are the surroundings of the North Pole? Those of the South Pole?

BOOK II

WONDERS OF INDUSTRIAL DEVELOPMENT

An Absorbing Story of Industrial Progress. Marvelously Effective Transportation Methods of Modern Times. Triumph of Scientific Construction. Unparalleled Development of Agricultural, Mining and Manufacturing Industries.



PRESSROOM OF A GREAT METROPOLITAN NEWSPAPER.

The peculiar curved troughs or channels, rising from the presses to the ceiling, are the carriers through which the completed papers are hoisted automatically to the delivery rooms above.

WONDERS OF INDUSTRIAL DEVELOPMENT

THE INDUSTRIAL AGE

Some periods of history are noted for their wars, such as the age of the Crusades; others, for their peculiar institutions, such as the Age of Feudalism; still another for the great maritime activity, as the Age of Discoveries. In a similar way, the present age, in whatever way it may be designated, is rightfully described as the Industrial Age.

This description is especially true of recent decades, which have witnessed a wonderful development of engineering projects, of great manufacturing enterprises, rendered possible by vast aggregations of capital, able to utilize the triumphs of inventive genius and the results of scientific research, under the leadership of veritable captains of industry—all of which sharply marks off the present from all other periods as being the age of marvelous advance in every department of science, of growth in all that constitutes civilization and makes for individual and national well-being.

In this book we will set forth in as orderly a sequence as possible the principal features of various great industries, which mark the present age. All great industries advance together. Improved methods in the production of iron and steel are speedily followed by more stately buildings, more efficient railroads, more wonderful machinery. The same is true of all industries.

But it will be admitted that industrial advance depends above all else on the spread of information, on the mutual exchange of thoughts. This was certainly very slow before the invention of an alphabet, and consequent writing. It is not at all surprising that the primitive stage of culture was prolonged through many centuries. With the invention of printing, thought flowed freely from people to people, from center to center. Then first did advance in culture, arts and science become marked.

So it is not out of place to begin our story of the Industrial Age with a brief account of the invention of printing, trace in a general way some of the steps in advance, especially recent developments, which have made possible the libraries of to-day wherein is stored the knowledge of the world, and that marvelous institution, the newspaper, wherein an account of all important events that have transpired in distant lands, recent achievements in science, industrial development in all possible directions, is brought to us day by day.

MARVELOUS DEVELOPMENT OF PRINTING APPARATUS

The first method of printing known was that of the Chinese which was done from engraved blocks, a brush being rubbed over the paper laid upon the form of type. As early as the 15th century, the principle of printing from forms upon a flat bed beneath a cylinder was understood and put to practical use. The presses, however, were wooden and rudely formed.

OLD-STYLE SCREW PRESS.

FIRST USE OF MOVABLE TYPES.

In the middle of that century Gutenberg printed a book from movable types. Two upright timbers with crosspieces of wood at the top and bottom constituted the outer frame of his press. Other crosspieces held the flat bed containing the type, and through still another intermediate slot passed a wooden screw, its lower end touching the center of a platen of wood and screwing it down upon the type.

The form was inked with a ball of leather stuffed with wool, upon which the paper was laid. On this paper a fragment of blanket was spread to make the platen smooth and soften the impression. The idea of the machine was based on the cheese and linen presses used in medieval households. The type of the present time is practically identical with that used by Gutenberg in printing his Bible.

For about 150 years the wooden press, operated with a screw and movable bar, was used without much modification. The forms, however, sometimes rested upon stone beds held in frames styled coffins, and were moved by hand. The platen was screwed up with the bar after each impression, in order to withdraw the printed sheet and hang it up for drying.

BLAEW'S IMPROVED PRESS.

About the year 1620 this press was first improved by a printer, of Amsterdam, named William Jensen Blaew. He ran the spindle of the screw through a square block guided in the wooden frame, and by cords or wires suspended the platen from this block, which prevented the platen from twisting and equalized the motion of the screw. This press was used in England and on the continent, and was nearly identical with that operated by Benjamin Franklin when he worked as a journeyman in London.

FIRST CAST IRON PRESS AND FIRST LEVERS USED.

About the close of the 18th century it was found necessary, particularly in the printing of wood cuts, and because of the size of larger forms of type to secure greater power for the impression. This led the Earl of Stanhope to construct a frame of cast iron, and, to facilitate the manipulation of the screw, he added a combination of levers which enabled the pressman to bring more force to bear, with less exertion.

FIRST PRESS WITHOUT A SCREW.

Shortly after the year 1800, George Clymer, of Philadelphia, contrived an iron machine without a screw. Over the platen was placed a long, heavy, cast-iron lever. One end of this was fastened to an upright of the frame, and the other end was raised and lowered by a combination of smaller levers operated by the pressman in a manner similar to that of the common hand press. A spindle or pin, attached at the top, to the center of the large cross lever, and properly balanced raised and lowered the platen when making the impression. This press was used in England.

FIRST FLAT-BED CYLINDER PRESS.

Friedrich Koenig, of Saxony, introduced the first press of the above description into use in England in 1812-13, and in 1814 he patented a continuously revolving cylinder press which printed one side of a paper at the rate of 800 sheets per hour.

SCREWS AND LEVERS REPLACED BY TOGGLE JOINT IN PETER SMITH'S INVENTION.

Peter Smith, of New York, who was associated with R. Hoe & Co., contrived a cast-iron press in 1822, in which he replaced the screw and levers with a toggle joint, which simplified the operation of the machine and rendered it more effective.

RUST'S IMPORTANT IMPROVEMENT.

Smith's invention was greatly improved upon in 1827 by a device perfected by Samuel Rust, of New York, in which the frame was not all of cast-iron, but had the uprights hollowed for the introduction of wrought-iron bars fastened to the top and bottom of the casting. This feature greatly lessened the quantity of metal in the press, while adding to its strength. Rust's patent was bought by Hoe & Co., who improved it materially and manufactured and sold it extensively.

In this press (the Washington) by turning a crank, with belts attached to a pulley upon its shaft, the bed is run out and in from under the platen on a track. The platen is raised by springs on each side, and a curved lever acting on a toggle joint impresses it upon the form. A tympan frame covered with cloth and inclined so as to receive the sheet of paper is attached to the bed. Another frame, the frisket, covered with a sheet of paper, is attached to the tympan. That portion of the sheet which would naturally receive an impression is cut away, as, otherwise, the chase and furniture would smear it. Over the sheet and tympan the "frisket" is turned down, and in making the impression all are folded together. The machine has automatic inking rollers, which the pressman operates by a weight. The descent of the weight draws the rollers over the type and returns them to the inking cylinder, while the pressman places another sheet upon the tympan.

Hoe & Co. also improved this press by providing a steam-driven apparatus, which distributes the ink on the rollers and makes them move over the type at will.

Fine books and cuts were commonly printed by the bed and platen method until 1850, the first steam-power, wooden press of this kind having been made by Daniel Treadwell, of Boston, in 1822.

The next improved press of Hoe & Co. printed papers of four, six, eight, ten or twelve papers at the rate of 24,000 per hour and sixteen-page papers at 12,000 per hour, the odd pages being in every case accurately inserted and pasted in and the papers cut at the top and delivered folded. The machine is constructed in two parts, the cylinders in one portion being twice the length of those in the other. The short cylinders are used for the supplements of the paper, when it is desired to print more than eight pages. The plates being secured on the cylinders, the paper enters from the two rolls into the two portions of the machine, through each of which it is carried by two pairs of type and impression cylinders, and printed on both sides, after which the two broad ribbons or webs pass over turning bars and other devices, by which they are laid evenly, one over the other, and pasted together. The webs of paper then pass down over a triangular "former," which folds them along the center margin. They are then taken over a cylinder, from which they receive the final fold, a revolving blade within this cylinder projecting and thrusting the paper between folding rollers, while at the same moment a knife in the same severs the sheet and a rapidly revolving mechanism resembling in its motion the fingers of a hand causes their accurate disposal upon traveling belts, which conveys them on for final removal.

What is known as the "Quadruple Newspaper Press," constructed in 1887, was developed to a greater extent. The supplement portion of the press was increased in width, and by ingenious devices the press was made to produce eight-page papers at a running speed of 48,000 per hour; also 24,000 per hour, of eight, ten, twelve, fourteen or sixteen-page papers, cut at the top and pasted and folded, ready for the carrier or the mails.

In 1889, R. Hoe & Co. made the "sextuple" machine, which occupied about eighteen months in construction, and is composed of 60,000 pieces. It is fed from three rolls, each being more than five feet wide. In a single hour it will use up twenty-six miles of this paper. It can print and fold 90,000 Heralds in an hour, which means 1,500 copies per minute, or twenty-five copies every second.

The latest and most elaborate newspaper machine is the Octuple Perfecting Press with Folders, which prints from four rolls, each four pages wide; and gives (from the four deliveries) a running speed per hour, of 96,000 four, six or eight-page papers; 72,000 ten-page papers; 60,000 twelve-page papers; 48,000 fourteen or sixteen-page papers; 42,000 eighteen-page papers; 36,000 twenty-page papers; and 24,000 twenty-four page papers.

PRINTING FOR THE BLIND

About 1,000 different books which, with numerous editions, totaling over 250,000 volumes, have been printed for the use of the blind. In addition, there are magazines published for their use. No ink is used in printing, but a special embossing press is employed. The process is slow and painstaking. The letters are about one-fourth of an inch in height, and raised about one-sixteenth of an inch, with plenty of space between the lines. The reading is done by the sense of touch.

THE TWENTIETH CENTURY DAILY NEWSPAPER

HOW IT IS MADE UP AND SENT OUT.

Among the forces that have worked for progress in civilization, none is of greater importance, and yet is more misunderstood, than the modern newspaper. In point of both literary and mechanical perfection, the American daily paper stands supreme. Not only does the metropolitan paper of the United States excel its foreign contemporaries in both bulk and circulation, but it is almost entirely free from the blot of subsidy which smirches so many papers in Europe. Being untrammeled by any but self-imposed checks or hindrances, the American daily is the best exponent of the freedom of the press, and in its fearless attitude in all matters, serves the public with a unique and honest loyalty.

While every one is acquainted to a great extent with the salient points of American journalism as exemplified in any one of the many thousand papers constantly read in the American household, there is an aspect to the progress made in the last few years which to the average mind is most marvelous. This is that feature of the work which enables a journal to gather the news of the whole world, and to deliver it in printed form within a few hours of the date of the matter chronicled, to thousands upon thousands of subscribers in their homes, many of them hundreds of miles away. To the unprofessional mind, the work of this public servant seems lighted by a halo of mystery. There is, in truth, much about the up-to-date newspaper plant to mystify, but let us here unravel the mystery.

For convenience a business-like newspaper plant is divided into a number of departments, usually as follows: editorial, circulation, advertising, general business, and mechanical. Each of these divisions is in charge of a superintendent, whose duty it is to see that the work of his department goes on with the utmost precision and accuracy. These superintendents in turn confer with each other or are instructed by a general manager, as to that ultimate combination of their forces which produces a perfect newspaper. About 600 people constitute the working force of the metropolitan daily. From start to finish, from office boy to publisher, speed is a requisite. This may be understood when it is known that

AN OLD TIME PRINTER

from the moment the gathering of a day's news begins, until it is printed by the half million copies, and is speeding on its way, by fast mail, to be read by millions, but from six to twelve hours elapse. Let us note the process by which news is picked up and made of commercial value.

THE VARIOUS STAFFS.

At the head of the editorial department stands the managing editor, who is responsible for his department to the editor-in-chief and publisher, and to him are responsible the numerous city, associate and sub-editors, and reporters. In general, each of the staffs of a paper is made up of over twenty-five men. Those whose work it is to issue the evening editions come to work before seven o'clock in the morning, relieving men already on duty. Until the last regular evening edition is printed and away, these men are on duty. Overlapping them and coming to work about noon, is the staff of men who issue the following morning's edition. While following upon this other staff, comes the third force near midnight, working until relieved by the next day's shift.

Each of these staffs is divided in such a manner as most effectually to "cover" the news of the world, and to write and prepare all reading matter, aside from advertisements, that appear in the paper. In order to do this, a number of men are assigned to take care of all the news in certain "departments," such as finance, music, the drama, railroads, politics, leading editorials, the funny column, etc. The routine news of the days is gathered in two ways—that from out of town by mail or telegraph and from special news bureaus and correspondents, and the city news, through a corps of local reporters. The former work is under the care generally of the telegraph editor, and the latter, under the city editor.

Telegraph news, while not always as interesting and valuable as important local news, yet plays a great part in every paper and relatively costs as much, and frequently more, than city news. The telegraph editor is assisted by several experienced men called copy readers. Since practically all the matter in the telegraph department comes to hand in written form, the duty of these men is principally that of reading it to see that the matter conforms to the general policy of the paper, and to correct any superficial errors. These men also write the large headings for the telegraph news.

While the work of editing telegraph "copy" in a newspaper office is something of an easy task, the gathering of this news has reached such a stage of perfection that it may be truly called marvelous. In the main most papers rely upon some news bureau for their out-of-town service. Large papers, however, retain correspondents in many cities (frequently employes of other papers), who gather special items not carried by the bureaus. These correspondents are in constant touch with the paper by mail and telegraph, and aside from a few representatives in very important cities, are paid according to the amount of news printed.

THE ASSOCIATED PRESS.

So intricate is the business of a well equipped news bureau, that it will be worth while briefly to describe the most important one of the kind, The Associated Press. This association is a corporation, not for profit, and consists of a mutual organization of over 600 of the most influential papers of the country. Its object is to gather the news of the whole world, and to serve its associated members therewith. In every large city in the world this organization is represented by an experienced newspaper man, whose duty it is to gather news worthy of national notice in the United States. Leased telegraph wire is spread across the country in every direction, connecting the principal offices of this organization. Special service is secured from the world's greatest cables. In times of storm, when wires are damaged, the first ones repaired are put in the service of this company. Every effort is made to circumvent time. The service of foreign news bureaus is secured to amplify the work of special correspondence. Thus if a queen dies at Windsor, a king is crowned at London, a new dictator assumes power in one of the Latin-American states, or a tribe of African savages swoops down upon a band of explorers, the news is flashed almost instantly to every newspaper in the association and shortly after appears in printed form for the edification of newspaper subscribers. In smaller cities this news is taken directly from the telegraph instrument by an expert operator, or is served to the newspaper as messages from one of the telegraph companies. In the large cities, where a number of papers are served, the association employs a staff large enough to supply each paper with type-written manuscript. This is usually sent by pneumatic tubes which run underground long distances, and connect the several newspaper offices.

LOCAL NEWS AND THE REPORTERS.

The gathering of local news devolves upon the city editor and his corps of reporters. By a simple method of keeping clippings of all notices of important events, to develop, and by carefully tracing down every clew that may lead to news, the gathering of actual happenings of importance in the way of news is reduced almost to clockwork precision. Every man connected with a newspaper is always on the alert for news. The reporters are assigned regularly to certain districts to gather whatever turns up in them. Police reporters are detailed to watch all accidents, crimes, fires, etc., that are reported at police stations. The society department keeps close touch with events of social importance. As in the telegraph news department, there is also a city news bureau in every large city. This bureau has a large corps of men covering routine work, such as courts, police stations, city, county and state offices, etc. Thus it is that all papers print, practically, all the news worth printing. Of course, a certain paper, through the large acquaintance of its best men, may now and then secure exclusive news, called a "scoop," but in the long run, one paper prints as many exclusive items as another.

ESSENTIAL QUALITIES IN THE NEWSPAPER MAN.

Of the newspaper man, himself, it may be said that he is essentially a worker. All sorts of ideas and things are material for him to work upon. His occupation is to him the breath of life.

Above all, to succeed, this man must use his every opportunity to the best advantage. To the person who knows nothing of his labors, he appears simply as the genial critic, editor or reporter, with something of a halo about him, denoting that he lives a life free from care and always to be envied. While there are phases of this sort in the life of the newspaper writer, they are exceptional, and the true basis upon which such men build their success is strenuous exertion. From beginning to end of his work day, he must be constantly on the alert for information that may develop into a "story" for his "sheet." True, nowadays, the management of a great newspaper is so methodical that a great deal of the work of the reporter or editor is laid out for him by men in higher authority. Yet, every moment there is some call upon even the youngest of the craft to exercise judgment and caution and a discrimination that is not often necessary in other callings.

To the powers that be in the realms of news, there is no such word as fail. If a rival journal has a piece of news exclusively, some one is responsible for its absence from your paper. It does not matter how many exclusive "stories" a man may deliver, how many "scoops" he may secure for his paper, if he is beaten, they count for naught. If he cannot do as well always as men on rival papers, he will lose his position.

And, further, the efficient newspaper worker must have perception and adaptability to handle a piece of news when he hears it. The well-equipped man is he who can write intelligently of a technical legal case as readily as of a midnight fire, of things financial with as much facility as of social matter. He must be able to grasp instantly the essential details of any occurrence that may be of value as news. Such a man has a smattering of legal knowledge, of the fine arts, of medicine, to say nothing of the intricate mazes of politics and political jobbery, of the wickedness of the under world and a hundred and one other phases of human action.

REPORTING A FIRE.

The actual course of a news story from the moment of the happening to the time it appears in print is something of a dramatic affair. If it is a big fire, when the fire alarm sounds on the special bell in the newspaper office, the city editor locates the conflagration and dispatches from one to ten men, including artists and photographers, to the scene. Generally these work under the direction of one man. Every detail possible is secured. The "office" is informed every few moments by telephone how the fire is progressing, and whether people are being burned or saved, etc. If the hour is late and occasions extreme haste, one man will telephone a connected story of the event to his office, and there it is amplified by an inside man. Pictures are taken and hurried back to headquarters for engraving.

"SCOOP" ON A SUICIDE.

If the story, instead of being common to other papers, is to appear exclusively in one paper, great secrecy is maintained. For instance, the writer overhears in a popular Chicago café, shortly after midnight, a conversation between two army officers about the suicide of a well-known military man at a fashionable hotel, on the eve of his wedding. Such news is "hot," and if true, would possibly be exclusive. Every effort is made to obtain the facts without arousing suspicion, and the next morning rival newspapers are filled with envy over a great "scoop."

THE CITY EDITOR.

After the "copy" of a newspaper "story" has been prepared by the reporter it generally passes through the hands of the city editor or one of his principal assistants, who judges of its news value in order to decide how important a position it shall hold in the printed paper.

THE COPY READER AND PROOF-READER.

From him it is turned over to the copy readers, whose duty it is to correct all errors due to haste—for haste is the one great requisite in newspaper work. They also write the large headings and intersperse sub-headings throughout the article. From the copy reader's desk the story travels to the typesetter, thence to the proofreader and back, in the shape of printed proof, to the editors and copy readers, who watch for errors which the proofreader may have overlooked. The course of the passage of the story through other processes will be found farther on, in the description of the other departments of the newspaper plant.

THE COMPOSING ROOM.

The composing room is the place where the typesetter, busy amid the hum of intricate machinery, puts into print the articles prepared by the advertising and editorial departments. The work done in setting the big display advertisements, which bring wealth to a newspaper, is done in much the same manner that typesetting was done years ago—by hand. This also is the case with most of the big headings of news articles. The setting of small advertisements and of the body of the paper is done, however, by machinery.

THE LINOTYPE.

The linotype machine which, as its name indicates, sets a line of type by machinery is one of the greatest inventions of the age. Its basic features were developed by Mergenthaler. This machine does the work of many men, and with such speed and accuracy that it is worthy of special notice. It has the appearance of a gigantic typewriter, and has for its main principle the automatic dropping of tiny brass molds for certain letters and figures, when certain keys are depressed. These molds are called matrices, and when a line of them has been set, they are flooded by a combination of molten lead and zinc, thus forming a line of type.

The linotype operator sits before his keyboard with his "copy" in front of him. With deft fingers he gently depresses the keys until he hears the warning of a bell, which tells him a line of matrices has been set. Then he presses on a lever at his side, the line is cast in metal, and a great arm reaches down, picks up the line of matrices and places them at the top of the machine for distribution. And here comes in one of the most delicate functions of the machine. Each matrix or mold, besides bearing the imprint of a certain character, is grooved much in the same manner as is a Yale key. Each of these grooves and their combination signifies the character the matrix represents. At the top of the machine is a distributing bar, which resembles a constantly revolving screw. After the line of type has been molded and the arm has delivered the line of matrices at the top of the machine, this distributing bar seizes them. They travel along on the screw until the grooves of the various matrices find their mates at little openings above the magazines which hold the matrices before use. Thus as each matrix is sifted from its mates by means of the grooves, it finds its way into the magazine for that letter, and is once more in readiness to be released upon the pressure of its particular key.

A FORCE OF LINOTYPE OPERATORS ENGAGED IN THEIR WORK.

After an article or advertisement has been set up in type, it is hurried over to the "form" or "make-up" table, where it is assigned its particular place in the page of type, is locked up in a great chase, and is sent to be stereotyped preparatory to going on the press.

STEREOTYPING.

The streotype department is the outcome of the necessity for rapid printing on cylinder presses. When the old-style hand or flat presses are used, type is frequently used just as it is set. Where newspapers, however, are turned out by the half million copies daily, another method is necessary. As soon as the form of a page of type is delivered to the stereotype department, it is the duty of the workers there to cast a duplicate of it in type metal, but in the shape of a half cylinder. This shape is needed in order to fit on the cylinder rollers of the steam printing presses.

The method of making this plate necessitates first the making of a mold which can be bent. This is done by taking an impression of the form in something that resembles papier maché. Thin layers of prepared tissue paper, with a sprinkling of a floury preparation between them, are placed on the page of type. Then the whole form is run through heavy steam rollers. This presses the paper well down into all the indentations of the type or illustrations in the page. In turn, this is run into a steam chest, where, in a very short time, the preparation is baked stiff. When the mold is removed, it resembles heavy pasteboard, and is the exact facsimile of the page of type. This matrix can be bent readily and placed within a cylindrical chamber, when it is at once flooded with type metal. Almost before the metal is cool enough to have congealed, the stereotypers have opened the molding chamber and have placed the semi-cylinder or plate upon an apparatus where all the imperfections may be chiseled out and the rough edges planed off. This work is so rapid that in a well-ordered department the plates are delivered hot to the press room. Different plants use somewhat different methods, some sending the plates by elevators down to the press room, and some of them being located in the basement of the building, adjoining the press room, receive the type forms from the composing room, and send them back by elevator.

THE PRESS ROOM.

Everything so far in the passage of the newspaper story from reporter to pressman has worked on rush orders and on schedule time. This is necessitated because the presses must be started at just the same moment every day. Great newspapers have subscription lists containing names of readers hundreds of miles from the city of printing. The papers to these readers must be sent over certain routes by fast mail trains, and to miss a train means that a rival newspaper will be read in many a town the next day, to the exclusion of its competitor. Thus in the editorial room an hour is set, a "dead line," so to speak, after which nothing can be written which will appear in regular editions of the paper. So is it with the composing room. Certain pages must "go down" to the stereotype room at certain specified times. The whole process from writer to press in rush times is frequently less than half an hour, but this is not the constant speed of the plant.

THE PRESSES.

Now, when the stereotyped plates are received at the press room the bustle begins in the great department of steam, machinery and noise. With almost lightning-like rapidity, the plates are clamped two on a cylinder of a press. The size of the paper to be printed regulates the speed of the press, as well as the number of cylinders to be used. Thus a great 20 or 24-page paper, coming from one press, means a dozen cylinders whirling.

Before the cylinders have been clamped into place, orders have been issued as to the size of the paper. Great rolls of paper, on spindles like gigantic spools, have been rolled into place on traveling cranes, and grouped about the presses, ready for immediate use. Some of them are already in place in the presses, like several spools of thread in a sewing machine. When the plates are all in order a signal is given, every man gets out of the way of the danger of crushed arms or legs in the immense rollers, and the steam is turned on by a great lever.

FEEDING PAPER FROM GREAT ROLLS.

The paper is fed from the rolls on the spindles down between the revolving cylinders and smooth steel rolls. This causes the impression, and prints the newspaper. In guiding the paper through the rolls cloth tapes are necessary to prevent the paper from slipping. After the paper is printed it passes over certain knives, paste brushes and folders, which sever the paper from the continuous roll, paste the leaves in position, when this is necessary, and fold the paper ready for the street. All this is done so rapidly that it can be counted only by machinery. Papers with only a few pages can be run out, ready for delivery, at the astounding rate of 48,000 an hour. An order was recently placed with R. Hoe & Co., for seven double octuple presses, equal to 28 quadruple machines, or 112 ordinary single-roll presses. These will print on eight rolls of paper the width of four newspaper pages, and when running to the full capacity the output from each will be equivalent to 200,000 eight-page sheets per hour. Eighteen hundred feet of printed webs of paper will pass through one of these machines every minute. The 16-plate cylinders each carry eight stereotyped plates, and 64 pages can be printed at will, in black or in colors.

FROM THE PRESS ROOM TO THE READER.

From the press room to the reader is comparatively as rapid as the other operations of the plant. Bundles, of several hundred at a time, are seized from the presses and hurried by automatic devices—little traveling elevators and cars—to the delivery room. Here crowds of newsboys and delivery men are eager to speed them on their way. Those papers that are to be read in the city of publication are hurried by fast wagons, elevated trains and street cars to every section, business or residential, of the great metropolis. On the morning newspaper this is done while the greater portion of the town still sleeps. The papers that are to be sent to suburban villages and distant towns take another course. The circulation department has already had prepared lists of all readers and dealers who get the paper. These lists indicate the post office address of subscribers, number of papers subscribed for and date of expiration of subscription. Long before the paper is printed, expert "mailers" have deftly pasted the little yellow slips from these lists on the wrappers in which the papers are to be mailed. This operation is done by means of a little machine called the "mailer," which can be used by one hand and made to paste the slips very quickly. When the papers are received from the press room, the workmen in the mailing room seize bundles of them, count them out accurately and swiftly, wrap them, bundle them into United States mail bags, and hurry them off in wagons to catch the fast mail trains.

MAKING THE ILLUSTRATIONS.

One of the great adjuncts to the latter-day journal is its illustrative features. A paper that does not print pictures, and many of them, is playing, as a rule, a losing game. This necessitates a photographic art and an engraving department. When an artist or photographer returns from an assignment to secure a certain picture for the columns of the paper, great speed is generally required. If it is a sketch, the artist has been working out his idea on the way to the office, in his cab or in the street car. In his studio, he rapidly makes the drawing of fire, wreck or person. Fine white Bristol board is used, and India ink leaves the lines black, for the engraver. The photographer, in case a photograph is to be used, has hurriedly developed his plate, and from it has had a picture printed on sensitized paper. Perhaps the artist must retouch this picture or redraw its fainter lines in ink. This is hurriedly done and the results are taken to the engraver. Here either of two methods may be used. One is the half-tone process, which is used principally for photographs of persons, and the other is the zinc-line etching for black and white drawings, sketched by artists.

In the latter method a "wet-plate" photograph is made of the artist's work, possibly of several sketches at once. This wet-plate photograph is much like the ordinary dry plate negative of the snap-shot photograph camera, excepting that the gelatine with which the glass is coated is yet wet when the picture is exposed. This gelatine is developed by ordinary photographic methods. Then the gelatine of several pictures is removed from the first glass used and pasted on heavy plate glass, a number of pictures in a group. After these have been dried hard by heat from a gas stove, this plate of pictures is enclosed in a frame with a sheet of zinc, sensitized after the manner of photographic paper. The plate is now exposed to the glare of an arc light. The sensitized zinc receives the impression from the light and negative, and after it has been developed and eaten down by acids, and by machinery which routs out imperfections, we have engravings of the pictures first drawn or photographed, now ready for mounting on metal bases for the printed page. In half-tone work, the process is similar, but when the photographs or artist's drawings are being photographed, fine screens intervene between the plate and the pictures, in order to give the mellowed shadings of the finer engravings.

Besides the departments already described there are the distinctively business offices, without which no paper can thrive. The circulation department canvasses, schemes and plots to secure a large number of readers for the paper. All sorts of devices are made use of. Prizes are offered, books and pictures are given away, and great quantities of advertised matter are sent out by hand and by mail. Men are paid fabulous salaries for ideas to swell the circulation lists.

THE ADVERTISING DEPARTMENT THE ONLY SOURCE OF PROFIT.

Of equal importance is the advertising department, which secures the large and small advertisements that are printed in all great papers, and from which the publishers obtain their profits, or, at least, the means to operate the newspaper; for, be it known, few newspapers make great profits. In fact, many are run at a loss, to support political parties, or to give power to some great capitalist, or, possibly, even as playthings for rich people. The advertising department maintains a corps of solicitors and clerks to gain business for the paper. Argument is constantly used as to the great circulation of this particular journal. Want advertisements, such as "servants" wanted, or other similar business or domestic wants, have become such a great feature in the advertising department of the paper that, in large cities, branch telephone offices are established all over town to facilitate their collection and transmission to headquarters. The advertisements of the great department stores frequently serve as the support of a newspaper. Big stores frequently use $25,000 worth of advertising in a single paper in a year.

The expenses of running a newspaper plant are very great. It should be known that hardly any large paper ever makes any money from its subscription list. The paper on which the journal is printed nearly always costs more than the printed paper bring in return. It is the advertising which counts, and the circulation list counts in turn only as it can give greater publicity to the advertising and thus serve as the means of securing much advertising matter and high advertising rates. It is figured, generally, that if a plant can deliver its publication without losing money on its selling price, it is in excellent condition. This, of course, is seldom the case with great Sunday papers, with their 50 and 60 pages of expensively-written and illustrated articles.

FOUR O'CLOCK A. M.—NEWSBOYS WAITING FOR THE DAILY PAPERS.

THE TRANSPORTATION INDUSTRY

RAILROADS

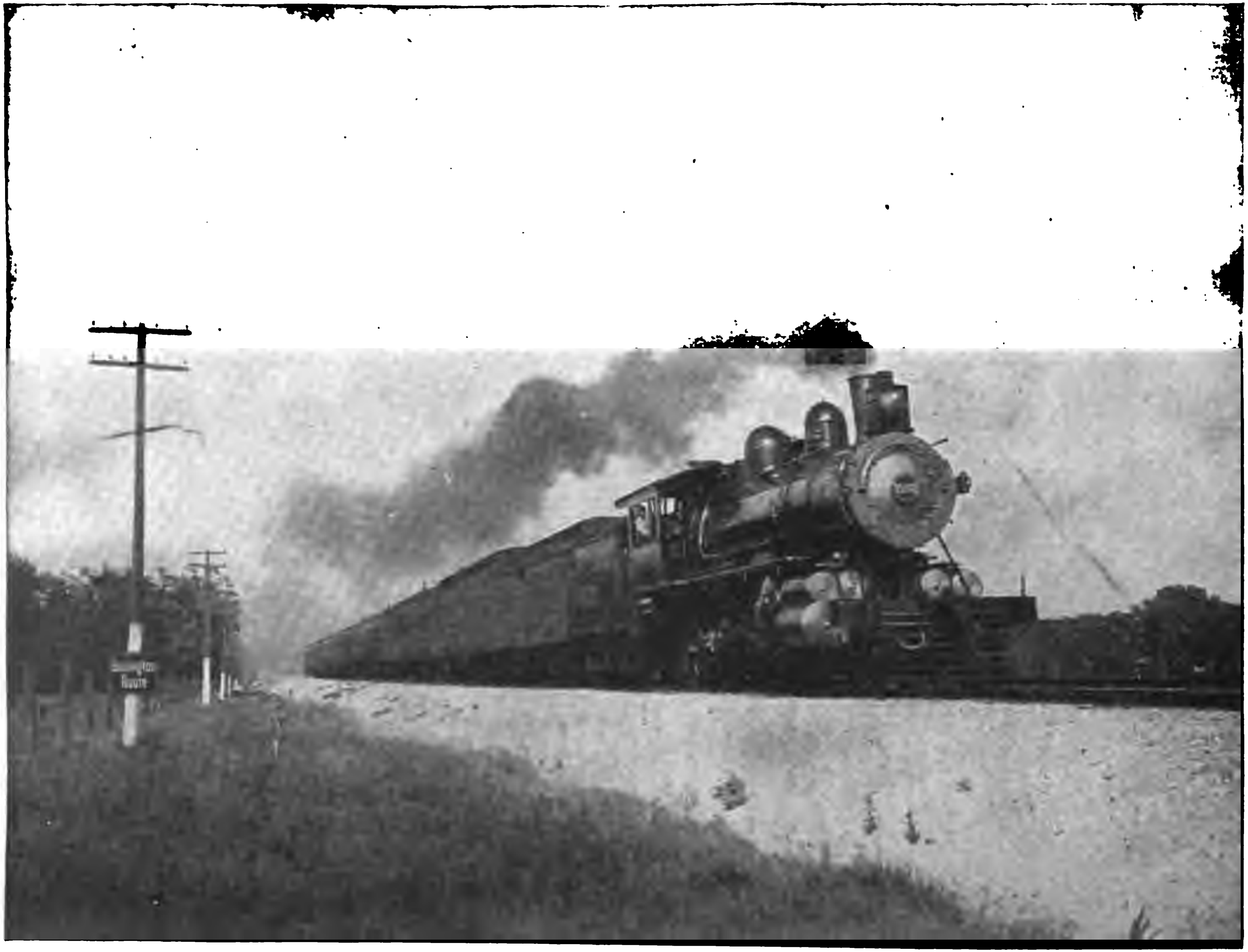
Civilization has advanced only as trade nd commerce have grown, for commerce is he life blood of civilization and transportaion routes are as veins, arteries and capilaries, which enable it to nourish all lands. At present, railroads represent the highest type of transportation, and will probably continue to be such for many years to come. To understand the Industrial Age, we must make a study of railroads, which are described as being the "greatest civilizing agencies the world has ever known."

When, to meet an emergency caused by the World War, the government took control of the railroads of this country, there were 397.104 miles of road, counting switch and other lines. If we consider only the main lines there are in the United States 265,000 miles of road. In the remainder of the world there are about 367,000 miles. It is evident that we far exceed any other country in the world in our railroad mileage. In all of Europe there is only about 217,000 miles; in Asia, 69,000; in South America, a little over 50.000; in Africa, 29,000 miles. Herein is to be found one of the explanations for our wonderful development in population and wealth. It requires the services of over 1.700,000 employees to properly man the roads. They carry a total of about one billion passengers a year and transport about two billion tons of freight. This vast traffic requires the use of about 60,000 locomotives, nearly as many passenger coaches, and about forty times as many freight cars of all descriptions.

About 2,000,000 names are on the payrolls. If we take into consideration those not upon the payrolls, but deriving their support from the railroads, and consider those engaged in manufacturing railroad supplies, we have between four and five million men deriving their support directly or indirectly from the railroads. Taking into consideration the families of these men, we learn that from one-fifth to one-quarter of the total population of the United States is dependent upon the railroads of the country. It is thus evident that railroads constitute the greatest single factor of this Industrial Age.

HISTORY OF THIS DEVELOPMENT.

This marvelous industry has developed in less than a century. The first railroad in the United States, built from the granite quarries at Quincy, Massachusetts, to the coast, was completed in 1826. The cars were hauled by horses, and it was only intended to transport stone to Boston. In 1827 the Delaware and Hudson Canal Company built a road 16 miles long from Homesdale, Pennsylvania, to their coal mines at Carbondale. Horses were used to draw the cars, but this road has the distinction of being the first one in America on which a locomotive was employed. Only by courtesy can these roads, on which horses were the motive power, be called railroads. The first modern railroad, though a crude affair, was the Liverpool and Manchester road, opened in 1829. The Baltimore and Ohio was the first road in this country designed to carry both passengers and freight. The first section, from Baltimore to Elliott's Mills in Maryland, was opened in 1830. Horses were used



THE LIMITED EXPRESS, RUNNING 60 MILES AN HOUR.

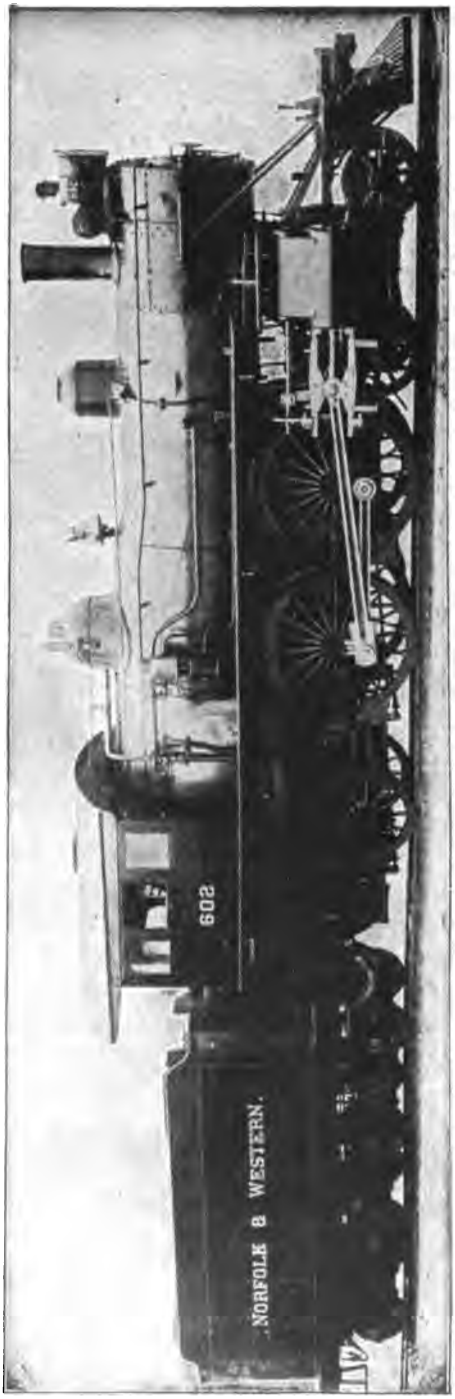
r two years before locomotives were nployed.

At the beginning of the Civil War, thirty ears later, only about 30,000 miles of railoads had been built in the United States. either the roadbed, the rails, nor rolling tock can at all compare with the massive quipment and large totals of our present igures, or the innumeral details by which ailroading has been perfected. Less than quarter of a century ago, on the average ailroad, the capacity of a freight car was 20,000 pounds. The engines then employed ould pull from twenty to thirty such cars in a train. To-day the standard freight car carries fifty tons; the locomotives have been increased in size and strength until they weigh on an average several hundred tons each, and they can draw from 50 to 75 such cars in a train, each loaded to its capacity; and in the busy seasons there are from 75 to 100 such trains daily passing over our prominent roads.

DEVELOPMENT OF PASSENGER TRAFFIC.

Before the railroads were built, it took a week to go from New York to Buffalo; nearly three weeks from New York to Chicago, and trips from New York to the Pacific coast were never thought of, except by hardy pioneers, who expected their good-bye to be forever. Now, the busy man in New York, after his noonday lunch and final instructions to his superintendent, departs for Chicago on the limited, which lands him at his destination twenty-one hours later. As for a journey to the Pacific coast, it is only a matter of four days' time from ocean to ocean.

And on the way, the traveler enjoys all the comforts of home; in fact, much more than the average home. A modern first-class



THE BALDWIN—A MODERN TYPE OF LOCOMOTIVE.

DINING ON THE LIMITED.

train consists of a baggage car, one or more day coaches, Pullman sleeping cars, a dining car, a library and smoking car combined, and on day trains a parlor car. The library car usually contains a bathroom and barber shop. It is solidly vestibuled throughout, thus excluding noise and dust, as one passes from car to car. At night the entire train is brilliantly lighted by electricity and in winter it is warmed by steam from the engine. Porters, waiters and maids are ready to attend to the wants of the passengers.

THE INFLUENCE OF RAILROADS.

The influence of railroads upon the material prosperity of the United States can not be overestimated. The vast stretch of country two thousand miles to the west, northwest and southwest of the Mississippi River, which annually produces supplies of grain, beef and minerals to the value of many hundreds of millions of dollars, wou still be the home of wandering India were it not that railroads make possible to transport its product The fruit industry of California, th timber industry of Oregon, the fish eries of the Puget Sound section, th mineral wealth of Montana, the whea from the great wheat belt of th North and West, would be virtually valueless were it not that railroads have met and solved the problem of transportation.

DEVELOPMENT IN OTHER LANDS.

This story of conquest is being repeated in other sections. The vast Dominion of Canada on the north. exceeding in area Continental United States, only awaits the further development of her railroad system to realize a wonderful growth in national greatness. Already railroads extending from Winnipeg west have opened up vast sections of such extreme fertility that many thousand settlers from the most fertile parts of

TRAVEL BY NIGHT—A SLEEPER.

the United States have been attracted thither. The "continent of opportunity," South America, is just beginning to feel the quickening influence of railroads. One of the most impressive pieces of railroad to be found anywhere is in Peru, from Lima to Oroya. It is one of the highest roads in the world and no other road lifts its passengers and freight by such steep grades. It is now being extended to the headwaters of the Amazon River. When South America shall have been seamed by the iron bands of many railroads, and transport found for the mineral wealth of Peru and Bolivia, the immense timber and agricultural resources of the Amazon Valley, we may expect a sudden expansion in wealth and national well-being hitherto unknown in history.

The old world is profiting by the experience of the new. Africa will soon cease to be called "benighted" for railroad development is coming. In the face of enormous difficulties, railroad construction is being pushed forward from Uganda to the Senegal, from the Zambesi to the sources of the Nile, and acress the desert expanses of the Sahara. The dream of a railroad from the Cape to Cairo is now almost realized. Asia is awakening to new life. India and China are arousing to once more become influential in the world's affairs. The cradle of early civilization, Baby-

Courtesy of the Pan-American Union.
ON THE OROYA RAILROAD.

RAILROAD MAKING IN AFRICA.

lonia, may again become renowned in history. In all this wonderful awakening, railroads, quickening the circulation of that on which civilization depends—trade and commerce—are certainly a most potent factor. The railroad which Russia flung across Northern Asia—from Moscow to Vladivostoc on the Pacific—is not only developing a wonderful extent of country, but is proving of inestimable value to Russia as a nation.

IN THE AFRICAN JUNGLES.

RAILROADS IN TIME OF WAR.

In modern days, railroads affording facilities for the transport of men, ammunition and supplies are a prime necessity. In the great European war, Germany was able to transport great armies back and forth from one frontier to the other, as her military policy demanded. In effect her strategical railroads double the efficiency of her forces The same was the case with other belligeren nations. Russia had to draw her army supplies from Siberia and her agricultural provinces. Her railroad across Northern Siberia was the great highway over which her supplies were brought, and we can understand why every tunnel and bridge and culvert was guarded by soldiers. It is not too much to say that modern warfare could not be proscuted without the aid of railroads.

This helps us to understand the great influence railroads exert on national well being. The thoughtful student realizes that in times of peace they develop a country by building up the industries, helping the circulation of that on which civilization depends, while in time of war they are a strong weapon of attack or defense. Such considerations show why the tendency is so strong for government ownership.

A RAILROAD ENCIRCLING THE GLOBE.

In the Western hemisphere, the various republics are completing in sections a railroad reaching from El Paso, Texas, through Mexico, thence to South America, ending at Buenos Aires. Considerable sections here and there have been completed, and in the course of a few decades that road may be an accomplished fact. In the meantime a more ambitious scheme has been proposed, which, when the Pan American road, linking up the republic of the New World is completed, will enable passengers to be transported from Paris to Buenos Aires. Taken in connection with the Russian railroad across Siberia, an American Syndicate is ready to build a standard gauge railway from the northwestern terminus of the Canadian Pa cific Road at Edmonton or Quesnella, to Vladivostock, including the crossing of Bering Strait.

This great, ambitious, Alexandrian scheme would encircle the earth with a double band of steel and the construction and operation of a railway system 20,000 miles in extent, traversing three continents, with one terminus at Calais on the channel coast of France and the other at New York City.

TYPICAL RUSSIAN LOCOMOTIVE IN URAL MOUNTAINS.

ON THE RUSSIAN SIDE.

On the Russian side the former czar's engineers made an accurate survey of the ground, and they found no such obstacles along the route as those which have already been overcome in building to the present terminus; for instance, that at Lake Baikal. This is a great inland fresh water lake, 1,560 feet above sea level, in a clef of the Baikal Mountains. It ranges in depth from 800 to 5,000 feet and occupies an area of 12,000 square miles, with a minimum width of thirty miles.

This great body of water has a distinct ebb and flow and current, and its high altitude has made it peculiarly the home of violent storms and intense cold. It was determined at first to ferry the trains over this gap, and for that purpose a steel ice-crushing ferry boat was built at a cost of $1,000,000.

But the incapacity of so cumbersome an arrangement soon became manifest, and the great thickness of the ice even further limited its usefulness, so that it was decided to build around the south, and this is now being done.

Bering Strait, between Capes Numiano, Siberia, and Prince of Wales, Alaska, is a fraction more than nineteen miles wide—a lesser distance than from Dover to Calais—

only one-fourth the width of the Yukon River, 1,200 miles above the mouth, when it is in flood, swollen by the melting ice and snow.

TUNNEL UNDER SEA.

The American project involves a tunnel for Bering Sea, which will not be nearly so difficult a matter as it would appear at first glance. To begin with, the Diomede Islands would break the continuity of a tunnel twice, so that no section of it need be more than six or seven miles long. Russia spent $400,000,000 building 5,542 miles. The new road, to make connections at both ends, will be nearly the same in length. Such a railroad would open up a vast stretch of territory and there is no more fertile land anywhere than southeastern Siberia and its millions of square miles of grazing, farming and fruit lands would almost support the world, if they were cultivated. They have been worked just enough to demonstrate their value. The mines of the farther north and in the mountains are among the richest on earth in gold, copper, coal, platinum, silver, salt, iron, lead, zinc and tin.

ON THE AMERICAN SIDE.

On the American side, the wealth of Alaska and the Northwest Territory is just becoming apparent. There are hundreds of millions of acres of land needing only that little impetus of the iron horse to make them rich and fertile. While the Summers are short, the days are nearly twenty-four hours long, and vegetation grows the entire time. It can be truthfully said that in spite of its location, far to the north, Alaska has sufficient agricultural possibilities to support a large population. The waters of Bering Sea and the Arctic and of the internal fresh water lakes and rivers will furnish enough fish to feed the world if need be, and the waters being extremely cold, the northern fish are noted for the delicacy of their flavor and the firmness of their meat.

There is that other phase of the proposition, however, that must appeal to all, namely, the saving in time in traversing the earth or any portion of it. Within ten years one may girdle the earth within twenty days.

RAILROADS IN ALASKA.

Alaska comprises an area of 590,884 square miles, and possesses vast mineral wealth. Since the acquisition by the United States, something over $800,000,000 worth of products, represented mostly in minerals and furs, have been taken out of the country. It is now known that vast deposits of coal and oil exist in addition to gold, silver and copper, and it possesses such immense supplies of timber as to be practically inexhaustible. But this mineral and forest wealth is valueless unless it can be transported. There are at present only about 600 miles of railroad in the territory. Further railroads on a generous scale are needed to properly develop the country. The expense and difficulties of construction are so great, that the government has come to the rescue, and Congress has appropriated $40,000,000 for railroad construction. When this shall have been liberally increased in future years, Alaska will become one of our richest sections. The prospector has proved that no other section of our land makes so rich a mineral promise, and the government has demonstrated that in agriculture Alaska will produce in abundance everything that can be raised in Scandinavian countries. It is estimated that there are in Alaska 50,000,000 acres of land that will make homes for a people as sturdy as those of New England.

AUSTRALIA'S GREAT RAILWAY PROJECT

HOW ONE OF THE GREAT COLONIES PROPOSES TO HELP HERSELF.

Australia is the latest country to catch the transcontinental railway fever and, with an energy characteristic of pioneer lands, has taken the most direct way of getting what it wants. The Parliament of South Australia has formally invited capitalists of Europe and America to bid for the contract of connecting the city of Adelaide on the south coast with Palmerston on the north coast.

BONUS OF 90,000,000 ACRES OF LAND.

Ninety million acres of land along the right of way, with all the minerals and other sources of wealth they may contain, are offered as a bonus to the company that has the courage to undertake a project that will cost from $30,000,000 to $40,000,000, and to operate a railroad through twelve hundred miles of semi-desert land that has only one white inhabitant to every three square miles. But 90,000,000 acres of land, even in the most unpromising region on the earth's surface, may well be a temptation when it is offered at forty cents an acre; and capitalists are not so much afraid of big railway ventures now as they were before the Union Pacific was finished, thirty-five years ago.

England is constructing the "Cape to Cairo" to connect Egypt with Cape Town, and Belgium, England and Germany will cross this line in the Congo country with a road running from the Atlantic to the Indian Ocean. It is now possible for passengers to step on board a train in any European capital and steam away across Central Asia for Canton, China, over the Chinese-Eastern Railway.

DIFFICULTIES OF BUILDING ACROSS AUSTRALIA.

In many ways this proposed Australian railway line, when it comes to be built, will encounter the same difficulties that were met in the building of the Union and Central Pacific roads. There is no mountain system to be crossed and no great rivers to be bridged, but there are broad reaches of desert as hot as those of Arizona and so little known that the maps show blank spaces for hundreds of miles in extent. All Australia taken together is within 50,000 square miles as large as the United States. In the interior deserts ten states as big as Pennsylvania could be dropped down and lost.

Although the distance to be covered is only 1,200 miles, or as far as from New York to the Mississippi River, the cost will be something enormous, and the returns must, for years, be a matter for conjecture rather than a matter that can be figured out.

The bonus offered is about 15 per cent of the entire area of South Australia. The United States gave only 25,000,000 acres to the Union and Central Pacific for building a road twice as long.

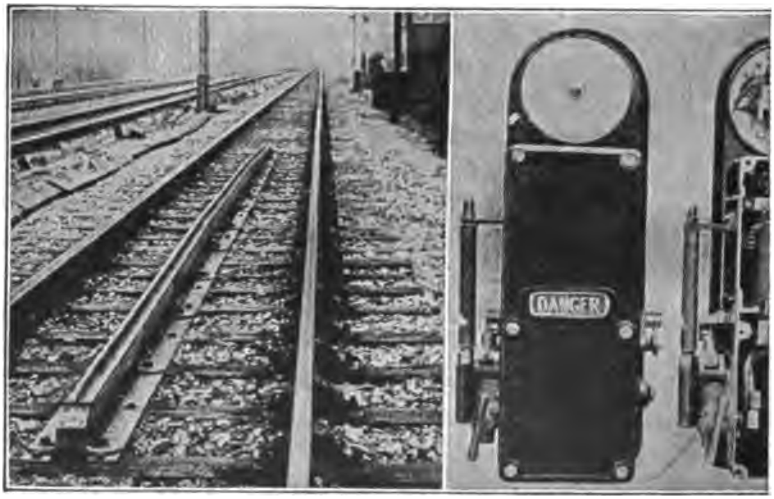
It is confidently believed in Adelaide that Canton, China, is to be the great port of debarkation for European traffic to the east, and that Palmerston, South Australia, only ninety-six hours from Canton by fast steamer, is to become the great Australian seaport to connect with Europe.

PRESENT DAY DEVELOPMENT.

Railroad development is by no means completed. The present mileage is far from being uniformly distributed in the United States. For each 100 square miles of area in New Jersey, Massachusetts, Ohio, Pennsylvania, Connecticut, Rhode Island and Illinois there are from twenty to thirty miles of railroad, but Idaho, Nevada, Wyoming, Arizona, New Mexico have only about one mile for each 100 square miles of area. These states lying north of the Ohio and the Potomac and east of the Missouri, comprising more than half the nation's population, but less than one-fouth of the territory have fully half of the mileage. It is evident we will need a greatly increased mileage in the future.

THE PULLMAN.

Great improvements are continually being made in the lines already in operation. Improved rails, improved roadbeds, steel bridges and culverts, cutting down grades and eliminating curves and grade crossings, are going forward, and the equipment is being continually improved. Electricity is being more extensively employed. Methods of signaling to moving trains have been devised. One method is to place a section of a third rail 60 feet long between the other rails at intervals of a half mile. A shoe suspended from the locomotives makes contact with each section as the locomotive passes. Electric wires connect with the distant signal towers and the operator can thus cause the signal box in front of the engineer to indi-



SAFETY DEVICES.

cate a clear track or blow a whistle, or show the word "danger." In short the operator can control the moving train.

THE RAILOPHONE.

The Railophone is a practical device by means of which telephone or telegraph messages, or signals can be transmitted to and received from a train in motion. The transmission is affected by induction from a wire near the train. The current rings a bell to attract the attention of the train crew. It is also possible to automatically set the brakes on a moving train from a distant station by this device. In a recent demonstration messages were sent from a moving train to a distant station and received from the station by the train. Further the train was stopped automatically by the station operator, and was unable to enter a block until the brakes were released from the station. If railroads were equipped with this device, the unfortunate despatcher who discovers he has two trains approaching each other on a single track, instead of giving away to despair, or stoically ordering out the wrecking crew, can quietly stop one or both trains and straighten matters out.

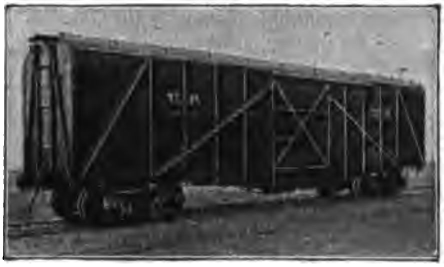
IMPROVED PASSENGER COACHES.

The American passenger car is the outcome of a remarkable yet gradual development. Invention has followed invention, discovery has succeeded discovery until the present result has been reached, steel springs, steam heating, electric lights, have replaced rubber springs, coal oil stoves and oil lamps. The old fashioned platform, buffer and coupler have given away to the solid vestibuled train, furnished with air brakes and modern coupler, to perfect which, it is said, over 6,500 patents were taken out. All this makes for the comfort, safety and speed of the traffic. The sleepers, drawing room cars and diners are models of comfort and efficiency. The use of wood in the construction of passenger cars is giving away to steel. Accidents will still happen and passengers be injured and killed, but the steel car is not reduced to kindling wood and burnt to the horrifying accompaniment of imprisoned and helpless passengers.

THE DRAWING ROOM CAR.

IMPROVED FREIGHT CARS.

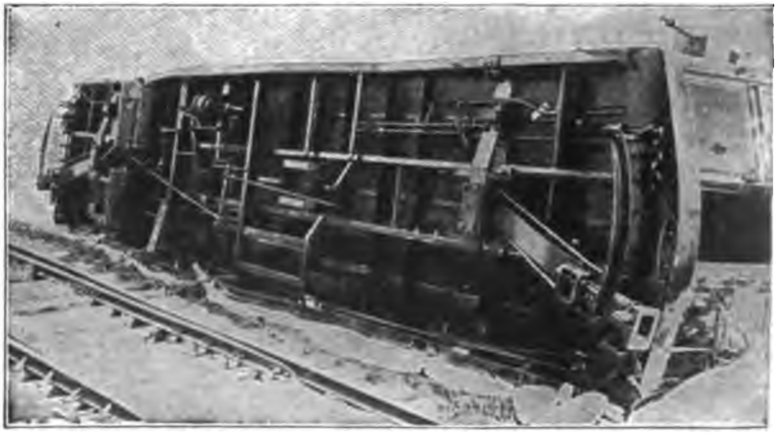
The freight car has continually grown in weight, strength, size and convenience. Steel is extensively employed. In some types it is the only material used and the growth of this industry has been very marked. One company uses about 2,000 tons of steel daily in making steel cars. The following figures show the increase in carrying capacity of freight cars. The normal capacity in the sixties was about 15,000 pounds, which increased to 28,000 pounds by 1873; to 40,000 in 1875; to 60,000 in 1885; to 70,000 in 1895. Now the standard is from 80,000 to 100,000 pounds per car. But as a result of all this development, passengers and freight are carried far cheaper in the United States than any other country, the average cost of moving a ton of freight being only about 40 per cent of the average cost in Europe. It is such facts as these that explain why it is that the United States is so far ahead of European countries in manufacturing, and why it is that while the standard of living is higher in this country than in Europe and consequently wages are higher yet we can compete with Europe in the markets of the world. We have solved the problem of transportation in far more satisfactory manner. Not only is our mileage far greater than any other country, but we increased its efficiency in very way possible. Our equipment is more massive, our engines more powerful, and no country has done more to develop its railroad system. It will surely be a short-sighted public policy which would seek to unduly restrict railroad development. Many think that legislation has gone too far in that direction at the present day. One thing is certain: railroads are a prime necessity and the United States can only hope to continue its growth by encouraging railroad development in all safe ways.



STEEL FREIGHT CAR.

RAILROAD COMBINATIONS.

Half a century ago, passengers had to change eight times between Albany and New York, and as many times more between Albany and Buffalo, though there were railway connection through the entire distance. It was inevitable that these numerous interests should tend to consolidate under one general management. In the last census year, most of the railway mileage was controlled by the following organizations in most cases named by the man or men who held controlling interests in them. The Vanderbilt System controlled 25,369 miles; the Pennsylvania System 20,320; the Morgan interests 21,411; the Harriman interests



STEEL CAR IN COLLISION—BUT LITTLE DAMAGED.

28,110; the Hill interests 13,410; the Moore-Reid interest 28,340, and the Rockefeller interest 17,000.

Such combinations tended to greatly reduce the expense of management, and improvement of services. The danger was that it placed large sections of the country in the industrial grasp, so to speak, of a few large corporations. The inevitable result was dissatisfaction of the people generally, ending by governmental control through the Inter-State Commerce Commission. It took many years to organize, develop and legalize this control but to-day it is very effective. In fact it is thought it has tended to become arbitrary and unjust; and one of the burning questions at present is whether railroads can flourish under present conditions. This deserves careful thought, for whatever tends to unjustly retard, check or cripple the railroad industry will injuriously affect the welfare of the general people.

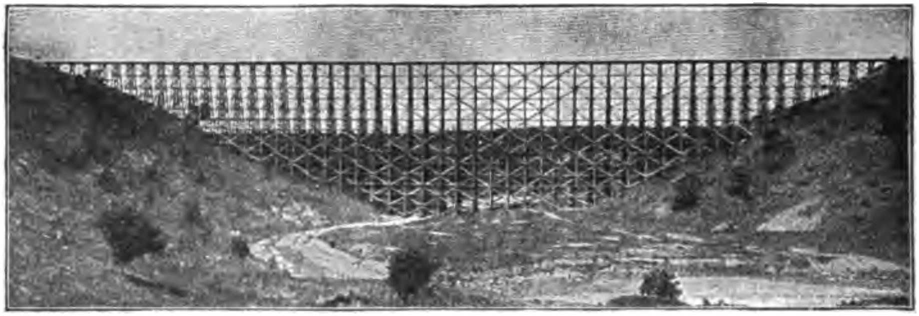
A 110-TON LOCOMOTIVE FOR HEAVY THROUGH FREIGHT.

ELECTRIC RAILROADS

At the present day, nearly all important towns in the United States enjoy the advantages of electric street cars, and inter-urban trolley lines radiate from all large towns linking up the smaller villages in the immediate vicinity and often stretch away a distance of from 75 to 100 miles to connect separate cities. The line of demarcation between urban lines in cities and inter-urban lines in rural sections is not clearly marked, so that figures are confusing, but there are 40,000 to 50,000 miles of inter-urban electric trolley line in the United States. This rapid development has been brought about within the last quarter of a century.

The central states of Ohio, Michigan,

Indiana and Illinois possess the most extensive and efficient high speed inter-urban railways in the country, and show most clearly the possibilities of this method of transportation. These fast inter-urban lines are tending to compete more and more with railroads proper for passenger traffic. Heretofore there has been a multiplicity of separate roads, but the tendency is as marked here as in railroads proper to combine scattered, smaller roads into one system; but even as it is, one can traverse whole states by trolley lines. Fast lines now maintain a speed nearly equal to that of the best steam railways. Limited trains are run, which stop only at the more important towns and both sleepers and diners are provided for travel between distant points. In these sleepers, revolving chairs instead of cross seats make the lower berth and wooden roller curtains are pulled up out of the floor to form the partitions. The cars are 56 feet long and weigh 50 tons each, but can accommodate only 20 passengers.



DEVELOPMENT OF THE TROLLEY SYSTEM.
Trestle bridge, 800 feet long.

EXPRESS AND FREIGHT BUSINESS.

The express and freight business on the inter-urban lines has not as yet been extensively developed, though it is growing and only awaits combination of interests to become very great. Some roads are now reporting a rapid growth in freight business, which promises to be very important in the future. Largely the goods transported are those which were not carried at all before, or else were transported by wagons. The farmer who lives within a reasonable distance of the electric line can send milk, butter, provisions, vegetables, etc., to market more promptly and easily than formerly. In the same way he can more easily obtain supplies from the city. Here promises to be a great increase in what might be called capillary circulation of commodities, and we must remember that just such factors as these exert a profound influence on civilization.

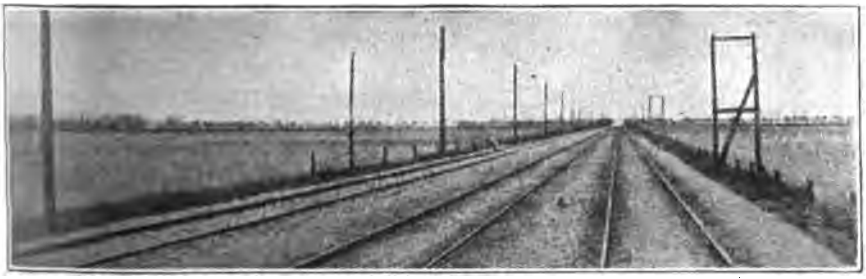
A TROLLEY SLEEPING CAR.

LARGEST AND FASTEST TROLLEY CAR

110 MILES AN HOUR.

One frequently reads about trains going at the rate of 100 miles an hour, but few people have ever ridden at a speed of more than 75 or 80 miles. On a little railroad extending from the suburbs of Berlin to the town of Zossen, an electric car travels daily as fast as 110 miles an hour, which breaks all records for speed on the highways of steel.

It is what we call a trolley car, but the trolley system is installed on a very elaborate scale, and the motive power which operates the car is simply enormous. The railroad on which runs this wonderful car is about 16 miles in length, and was built by the Prussian government for military purposes. A few months ago it was turned over to an association of electrical engineers and other experts, for the purpose of ascertaining what speed could be developed by the electric current. Then a car was constructed especially for the purpose, and when equipped with the necessary machinery, weighed nearly one hundred tons. The body of the car is similar to many of those in use on railroads in the United States, with a vestibule at each end, and the roof and sides tapering in order to offer little resistance to the air, when going along at the highest possible speed.

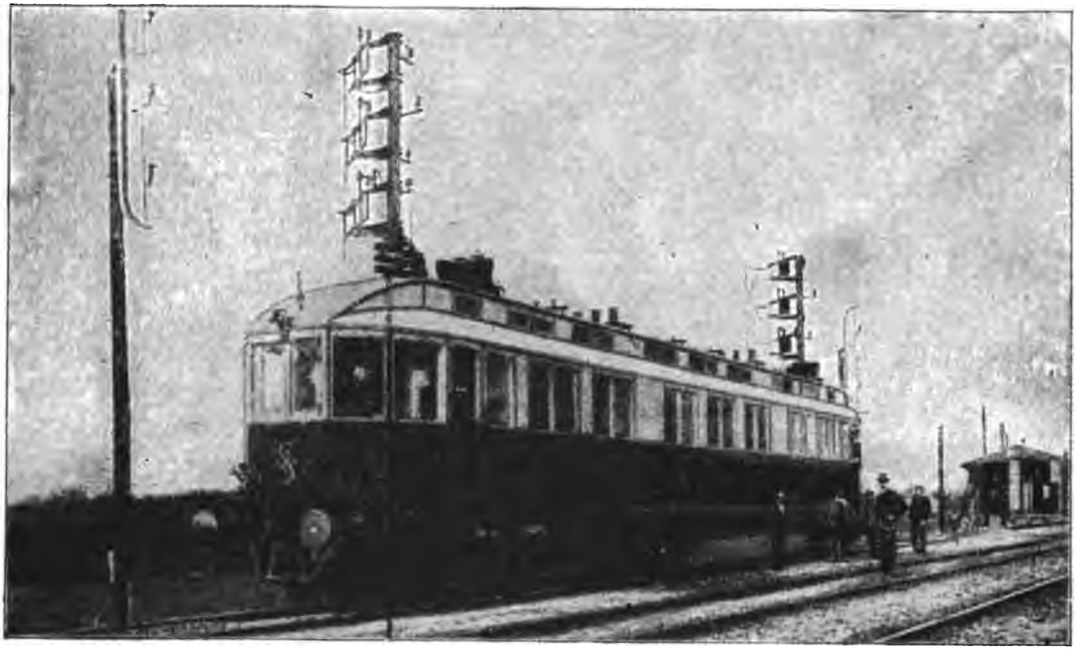


ROAD-BED AND FEED-WIRE SYSTEM FOR HIGH-SPEED ELECTRIC CARS.

The car is divided into three compartments with seats extending transversely, while the motorman is separated from the passeners by a glass partition. What engineers call the three-phase system of electricity is utilized for running the car and the two trailers which it has been hauling during the experiments. Instead of the current being conveyed by one or two wires to the motor, it passes over a series of four, three of which are carried along the side of the railroad upon posts. These are known as high tension, and are capable of supporting a curent of no less than 12,000 volts, owing to the system of conduction and insulation. The current passes through the trolley bar, which, as will be noticed, is a very elaborate affair, and thence through transformers to the motor.

The motors are bolted upon the axles of the trucks beneath the car, each motor being large enough to run an ordinary factory, as it can generate fully 250 horse-power under ordinary conditions. Although these ponderous pieces of machinery weigh no less than four and a half tons each, they move at the rate of 900 revolutions a minute, when a car is at full speed. It would be impossible to stop and start the car with the controller which the motorman uses on the ordinary trolley system, so special apparatus had to be provided for this purpose. The electric switches and transformers are moved by compressed air, which really does the duty of the motorman.

The inventor of this car claims that within a few years will come a complete revolution of travel on rail, and that electricity with cars of this type will make an average of one hundred miles an hour with as much ease as a speed of 50 miles an hour is now made. Recent experiments with this car have proved conclusively that it can go at a speed of 110 miles an hour without apparent danger, and with absolute freedom from swaying motion.



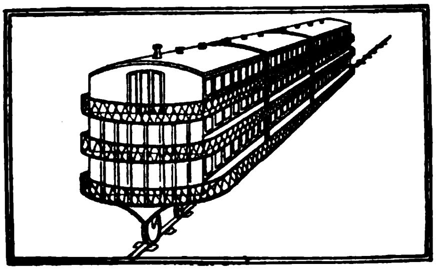
ELECTRIC CAR THAT RUNS 110 MILES PER HOUR.

ELECTRIFICATION OF RAILROADS.

A new age is beginning in railroading occasioned by the use of electricity as a motive power. In a few exceptional cases as in the tunnel approaches to large cities electric locomotives have been used. But at present many railroads are considering the question of making extensive use of electricity to run their trains not simply under special circumstances but as a general practice. In our chapter on electricity we considered some instances of such methods. It has many factors in its favor. It is far more economical power. It does work that no steam locomotive can handle, pulling heavier trains up grades at greater speed at greatly reduced cost. It is ready to start by simply turning a hand-switch, has no ashes to dump, no flues to clean, no boilers to inspect, requires no tender with water and coal, and as it works with equal cheerfulness either way, no turntables are necessary to point it right.

MONORAIL SYSTEMS.

There are two monorail systems projected, which may greatly modify railroad traffic in the future. In the Brennan system, the wheels are in a single row beneath the center of the car and run upon an ordinary rail, laid upon ties on the ground and the car is kept balanced by the use of gyroscopes placed within. It is claimed that the car of the future, in this system, may be several times as wide as now, and two or three stories in height and run at a very high rate of speed. The inventor asserted that it will be able to cross rivers and gorges on a single cable. These remarkable claims have not yet been confirmed by experience. The model worked all right, but it has not been successfully operated. Opinions differ as to whether it is practical or not. Some think it simply an ingenius, scientific toy, but others regard it as the greatest invention since the electric motor. In 1910 a monorail line three miles in extent was built in the suburbs of New York. But in this case there was a guide rail placed at a sufficient distance above the ground rail for the car to pass between them and double guide wheels on the roof of the car prevent tilting to either side. Though the gyroscopic monorail has not yet been a practical success, there is no telling what the future has in store along this line.

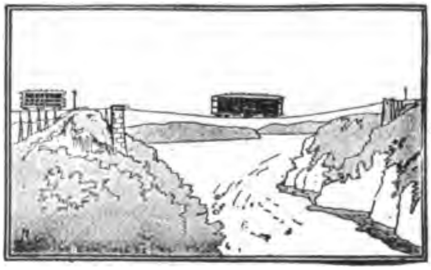


POSSIBLY THE FUTURE CAR.

Practical men, qualified to judge of the merits of the proposed car, do not think it will come into general use. It is pointed out, however, that in the construction of pioneer railways through undeveloped country, and particularly through mountains and hilly countries, where the line would be very circuitous, this form of construction has some advantage, since it could turn curves impossible for a two-rail road.

THE SUSPENDED MONORAIL SYSTEM.

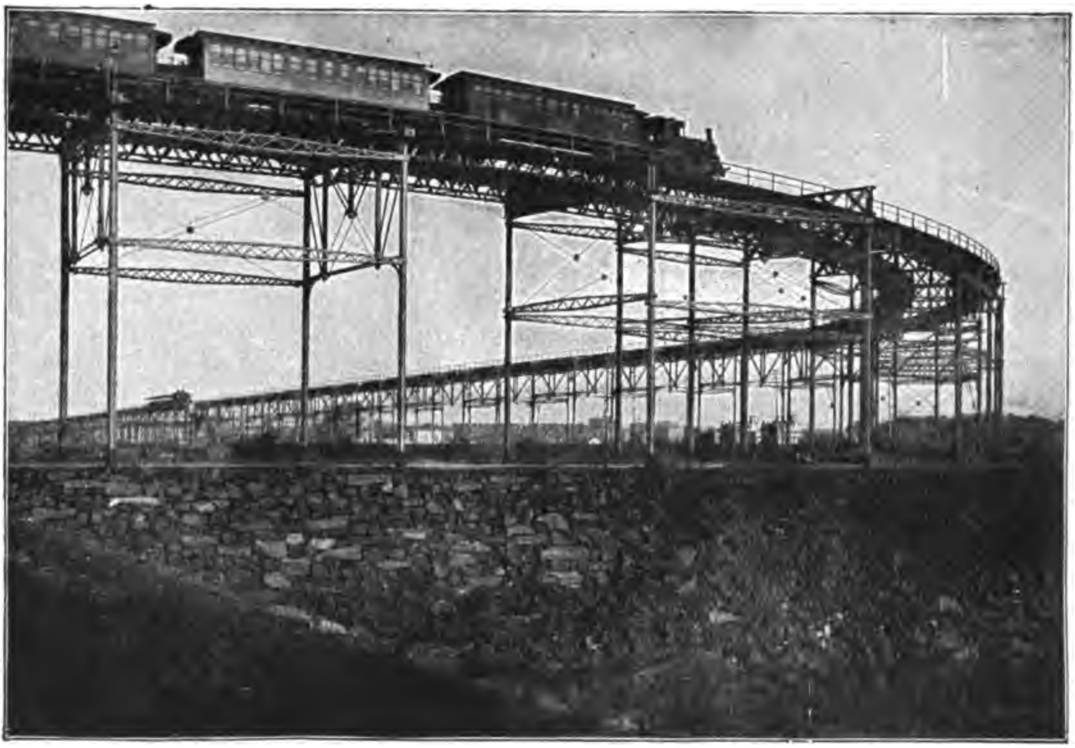
The suspended monorail system is in practical operation in Germany between Elberfield and Barmen for street car transport services and there would seem to be no reason why it could not be introduced for interurban needs generally. The cost of installation is much cheaper than the usual system, the cars can travel at high speed, in perfect safety, the bottom of the car may be on an average only a foot or so above the surface of the ground, when it comes to a stop at a station it is caught by grip and swaying motion is prevented. In the meantime, since the demand for increased speed in travel is never satisfied, a French electrician has recently brought forward an aerial suspended monorail that seems to be feasible and promises safety in travel up to 180 miles an hour.



CROSSING A RAVINE.

CITY TRANSPORT PROBLEM

All large cities are confronted with the problem of rapid transit. Hundreds of thousands of city population, living in suburb and outlying sections of the city must be transported daily to and from the business center. The usual means of travel by surface trolley lines is inadequate in the principal cities of this country, and Europe. Some means of transporting large numbers of people with very considerable rapidity is required. Two systems are employed, elevated surface railways and underground subways.



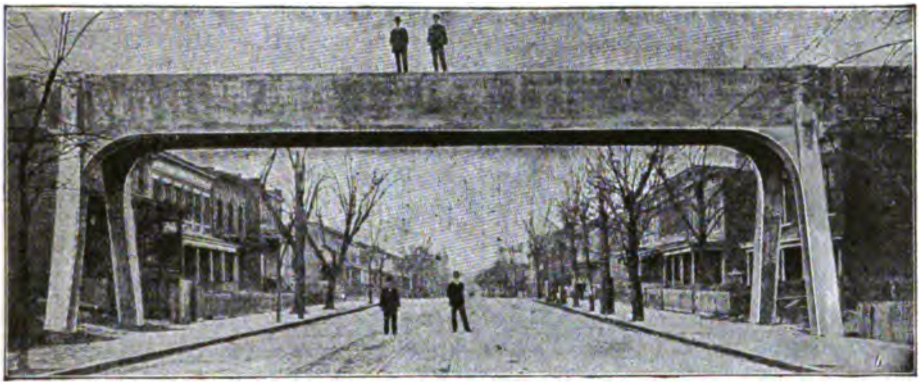
GREAT CURVE ON THE NEW YORK ELEVATED RAILROAD.

ELEVATED ROADS.

The elevated framework is of steel supported by steel pillars. Between these are stretched cross beams, upon which plate girders are laid. Ties are laid on the girders, which in turn support the rails. The whole construction is thoroughly braced. The stations are erected on elevated platforms of the same height as the track and are reached by stairways from the street, in some cases by elevators. The motive power is electricity, and trains of four and five cars each follow each other at two minute intervals during the rush hours, and about five minutes apart other hours. As they are generally crowded, some idea of the tide of travel to and fro can be formed. The first elevated road was built in New York in 1867, and extended in 1872. Now New York, Brooklyn, Chicago and Boston, and Berlin, Paris and Liverpool in Europe are well supplied with elevated roads.

CONCRETE ELEVATED STRUCTURE.

An interesting exception to the general rule of elevated construction is that of the elevated portion of the electric road entering Richmond, Virginia. The structure is built of reinforced concrete of the very best quality, calculated to withstand a pressure of 500 pounds per square inch and a shear of 50 pounds. The longest spans are over the streets, 67 feet, five inches in length, and are planned to support a train weight of 150,000 pounds. The height of the structure varies from 18 feet to as high as 70 feet in one place.



A CONCRETE ELEVATED STRUCTURE.

SUBWAYS.

Elevated roads are utterly inadequate for the immense tide of travel in such modern Babylons as London, Paris and New York. To meet the need, subways were introduced. London, with its 7,000,000 inhabitants, was the first city to adopt subways. At present there are two main systems in London and during the year nearly 300,000,000 passengers are transported by their trains. In places some of these subways are 100 feet below the surface, at one point 123 feet, at others they are so near the surface that only three feet overlay the tube. The average depth is about 60 feet. Elevators holding as many as 60 persons at a time are used at the principal stations to accommodate the patrons. There are also stairways. Ventilation is secured by immense revolving fans driven by motors. It is said that all the air in the tubes is thus changed hourly. The entire subway is brilliantly lighted by electricity. The trains are composed of six steel cars—a motor at each end—and four regular cars. The cars are each 50 feet long, 8 feet 8 inches wide, and capable of seating 52 persons. Twenty electric lights are placed in each car. Each subway is composed of two separate circular tunnels, lined throughout with cast iron segments bolted together. Each section is divided into blocks and provided with automatic train stops and telephone connection can be made at any point.

NEW YORK SUBWAYS.

New York has the largest underground passenger railroad in the world. It is 26 miles long and has 85 miles of track. A large part of the way there are four tracks—two for express, two for local. The subway is 54 feet 8½ inches wide over all; 16 feet 7 inches high. This roof is supported by steel columns. In the construction of this subway 97,500 tons of structural steel and 725,000 cubic yards of concrete were used. But these statistics will all be dwarfed when contracts now given shall have been completed, which call for 44½ miles of new subway and for a little over 53 miles of new elevated structure.

ENTRANCE TO LONDON SUBWAY.

The New York subway is an arcade rather than a tunnel. It is wide and light and well ventilated, with handsome, convenient stations, and a marvelously complete system of signals to avoid accidents. Enameled brick is used in lining the tunnel, electric lights placed in niches in the wall, illuminate the subway, and entrance to and exit from it are made by separate stairways. It has 800 copper sheathed and practically fire-proof cars working on the third rail system. In constructing the subway, the engineers had to solve one of the gravest problems ever faced in underground engineering. They had to blast and dig out about 3,000,000 yards of rock and earth; they had to explode quantities of dynamite—about 900,000 pounds in all—without seriously interfering with travel. In the way of their excavation, was a vast network of pipes and wire, high sewers, water mains and steam pipes, twisted and tough leaden cables, rusted and moulded channels of power and light and wealth—through this underground labyrinth the subway had to be constructed, and so while the blasting and excavating proceeded, this bewildering network of structure had to be protected in position. On the surface, hundreds of costly buildings had to be held in position by props against their foundation walls. It is not strange that mile for mile, it cost about 50 times as much as a high class railroad.

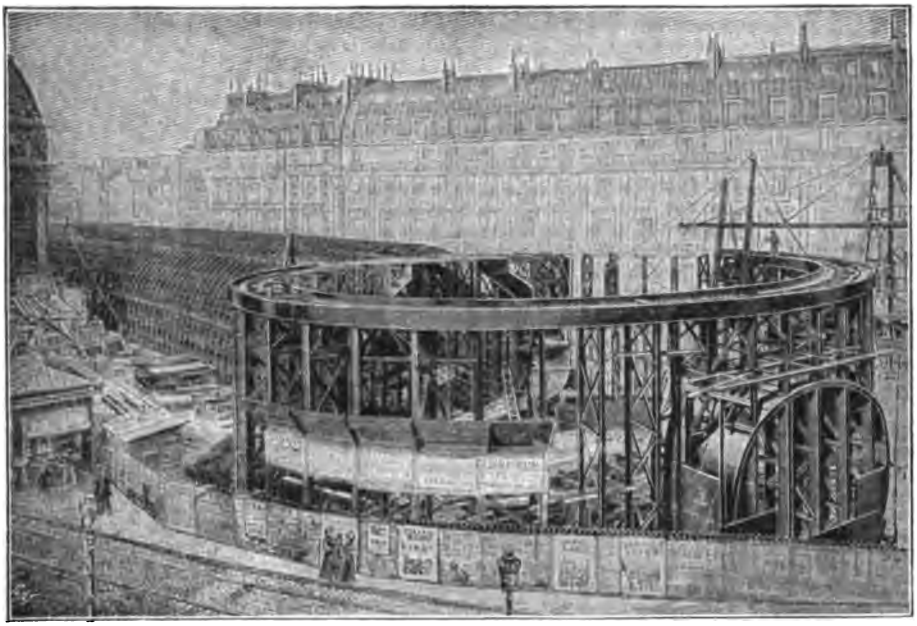
SIGNALS AND AUTOMATIC STOPS.

TUNNEL CONSTRUCTION IN EARLY TIMES.

The construction of this subway affords an interesting comparison between modern ability to construct difficult engineering work and that possessed by an ancient people, but the most advanced of their times. The Romans understood engineering and constructed many remarkable works. But in the palmy days of Empire, it required 30,000 men eleven years to construct a tunnel three and a half miles long. In these days, 12,000 men in four years constructed the New York subway, equal to at least 50 miles of the Roman tunnel, and in addition, in that time they also built ten miles of viaduct. All this work was done underneath the streets of a crowded city, and the work was rendered exceptionally difficult by the underground complication to which we have just alluded.

PARIS SUBWAYS.

The city of Paris, France, has also an interesting line of subways. A novelty in construction was first used in building this subway. Portions of it were constructed in the street, above ground, then the street was excavated and the massive sections of the tunnel thus built were allowed to settle to the desired depth. The illustration shows a section of the tunnel being built, together with one of the depots. The steel tube shown is itself surrounded by concrete. Inside is another layer of concrete, then the sides and arch were covered with white enameled tiling, the bottom with cut stone blocks. The depot and 500 feet of tunnel weighs 18,000 tons and we can understand the nicety of operation by which these various sections were sunk to an exact level, and then bolted together.



OPEN AIR CONSTRUCTION OF A PARIS SUBWAY.

SUBWAYS FOR CITY PIPES AND WIRES.

European cities are making extensive use of subways, not for the transport of people or goods, but to furnish a convenient place, in which may be placed gas and water pipes, also wires for the transmission of electricity for light and power, and for telegraph and telephone wires. In reality, these subways serve the very highest transport services. In London there are now many miles of them and one is planned whenever a new street is opened. Manchester is another city making use of such subways. It will be noticed the conduits in our American cities used for electric wires are analogous to these subways.

MANCHESTER SUBWAY.

RAILROAD TUNNELS

Railroads serve such an important part in the development of a country that great natural obstacles to their construction only rouse engineers to greater efforts in overcoming them. Rivers are spanned by bridges that excite the admiration of the world; tracks are laid along narrow ledges far up the precipitous sides of mountain canons; if all else fail; mountain barriers are pierced by tunnels, which call for the highest engineering skill.

THE HOOSAC TUNNEL.

This was one of the first important tunnels in the world, and is to-day one of the longest tunnels in the United States, being four and three-fourths miles in length, piercing the Hoosac Mountains in northern Vermont. It affords ready communication between New England and the West. It was an epoch making work in that it brought into use power worked drills and high explosives, thus inaugurating modern tunnel building. The tunnel is 24 feet wide, inside measure, and 22 feet 8 inches high, affording room for two tracks. Work was prosecuted from both ends of the tunnel and from the middle by means of a shaft 1,028 feet deep, which is now used for ventilation. It cost $11,000,000. Electricity was first used to haul the trains through this tunnel in 1910.

NEW YORK TUNNELS.

While the Hoosac Tunnel is one of the longest railroad tunnels in the United States, it is surpassed in importance by many short tunnels. The Hudson river tunnels, giving access to New York City from the West, and those underlying the East river, affording communication with Brooklyn, are among the most expensive short tunnels in the world. The Pennsylvania Railway Company has spent over $50,000,000 for its systems of tunnels under the Hudson, across Manhattan Island, and under the East River. These are in effect immense steel tubes, there are four of them under the East River, and two under the Hudson.

THE DETROIT RIVER TUNNEL.

There is a notable tunnel, two and a half miles long, underneath the Detroit River, affording easy communication with Canada and the East. This is an instance of a tunnel built on the surface, towed into position and sunk in a trench, which had been excavated in the bottom of the river for that purpose. That is to say, the tunnel was made in sections. Two parallel steel tubes were prepared, placed in position, 26 feet four inches apart. Each tube was 23 feet four inches in diameter, the outer covering was made of steel plate, three-fourths of an inch in thickness. This sheathing enclosed a layer of concrete 20 inches thick, reinforced by longitudinal steel rods. These tubes are surrounded by a mass of concrete, 55 feet 8 inches wide at the top, 30 feet 10 inches in depth, so as the concrete hardens there was formed a solid stone structure, traversed by two parallel steel tubes. The section was then placed in position in the prepared trench, the end securely joined in the preceding one.

SHIELD USED IN TUNNEL CONSTRUCTION.

THE ANDEAN TUNNEL.

There has recently been completed a tunnel in South America that is certainly one of the most important tunnels in the world. There are many tunnels, which exceed it in length, as it is only about two miles long. There is a short tunnel on the Oroya road in Peru constructed at a higher altitude, but there are probably none of greater importance. It affords railroad communication between Chili in the west and Argentina on the east. The journey between Buenos Aires and Valparaiso now requires only thirty-four hours. At present, Argentina is a sort of commercial appanage to Europe, but that tunnel and the Panama Canal should result in much closer trade relations with the United States. Enlarged trade between the east and west coasts of South America will develop that section of the country in every way.

SECTION OF A TUNNEL.

MONT CENIS TUNNEL.

The Alps have always been the great trade barriers between Italy and the rest of Europe. Within the last 50 years these mountains have been pierced by a number of great tunnels, each requiring many years time and the expenditure of vast sums of money to construct. The Mont Cenis Tunnel is situated 16 miles from Mont Cenis between the province of Turin in Italy and the Department of La Savoie, in France. Its total length is 40,084 feet, or 7.6 miles. The elevation of the southern entrance above the sea is 4,237 feet; of the northern entrance, 3,802 feet; of the terminating point, 4,247 feet. The tunnel is broad enough for two double lines of tracks.

THE ST. GOTHARD RAILWAY AND TUNNEL.

The St. Gothard railway is one of the most wonderful pieces of railroad construction in the world. Though only about 31 miles in length, it cost $52,000,000 to build. It passes through an extremely mountainous country, crossing 14 viaducts, 115 bridges and traversing 79 tunnels. It follows the valley of the Reuss River, running southward from Lucerne, and rising gradually as it passes the jagged Spannorter, and the glacier of Schlossberg. Every mile of progress entails tedious ascent. When the grade becomes too steep for the mountain-climbing locomotive, the road dives through the heart of the mountain and winds spirally upwards in constant ascent. Finally the great St. Gothard tunnel is reached, and the road plunges through nine and a quarter miles of solid rock. From this point, gradually, it begins its downward course through the interiors of four mountains, at last reaching the plains more than 3,000 feet below. The tunnel passes under a mile of solid earth. So great is the pressure on the tunnel that twice it crushed in. Now the roof and walls are held in place by huge arches of masonry, 15 feet thick at the sides, and ten feet at the roof. The building of the tunnel took one year for each mile and the cost was $11,350,000. With the most improved drills, compressed air, etc., the workmen could progress only 14½ feet in a day.

THE ARLBERG TUNNEL.

Another great tunnel through the Alps is the Arlberg. It is about as long as Mount Cenis,—six and a half miles,—yet it took only about one-fourth of the time to build. It was begun in 1880 and progressed at the rate of 27¾ feet a day, finishing in 1884. This tunnel facilitates trade in Austro-Hungary by connecting the province of Von Arlberg, through the Arl Mountain, with the rest of the Austrian Tyrol.

THE SIMPLON TUNNEL.

The Simplon Tunnel is the longest in the world. The northern terminus is reached by railway from Geneva. Its purpose is to save about forty-eight miles in the railway distance between Paris and Milan, as compared with the Mont Cenis and St. Gothard routes. The total length of the tunnel itself is nearly 12.3 miles from portal to portal. In reality there are two parallel tunnels, with a distance of 55 feet and nine inches between the centers of each, thus leaving a thick wall of rock to support the roof. There are side tunnels or chambers connecting the two tunnels at regular intervals. It cost nearly $14,000,000.

RECENT TUNNELS.

The Loetschberg Tunnel is the third longest tunnel in Europe, eight and a half miles in length; only the Simplon and St. Gothard tunnels are longer. It is a portion of a line connecting Western Switzerland and France with Italy, passing through the Bernese Alps. It is a double track tunnel, lined with concrete, one and a half feet in thickness. Within this it is 26 feet 3 inches in width and 20 feet high. The Richten tunnel is located in the Canton of St. Gallen in northeast Switzerland. It is 28,231 feet in length and shortens the north and south lines of travel in Eastern Switzerland.

OCEAN TRANSPORT

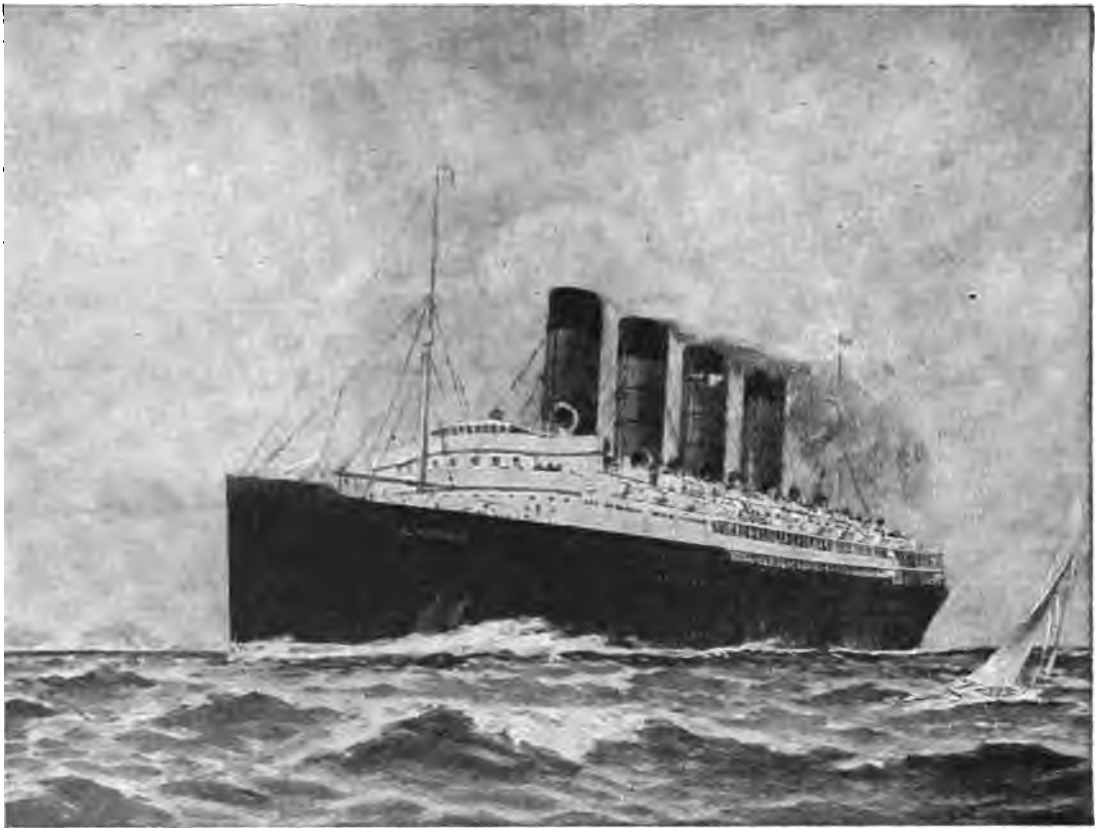
Land transportation is not the only or even the most important kind of transportation. The far larger part of international commerce is carried on by ocean going ships, and the internal commerce of any nation, as the United States, is greatly furthered by water transportation routes as the great lakes, rivers and canals. Vast quantities of heavy freight can only be transported economically by water routes. Early commerce was altogether water borne. Only of recent decades, within the last century, in fact, have railroads served the purposes of inland commerce.

Ocean commerce has increased by leaps and bounds in recent decades, and to care for that increased commerce there has been a corresponding increase in ocean going shipping. In four centuries the commerce on the Atlantic grew from such ships as composed the caravals of Columbus to the majestic ocean liners of to-day that throng the Atlantic, hurrying at express speed from shore to shore.

As regards the development of ships in size, speed and equipment, there may not be a great advance in the future. We seem to be approaching the limit in these directions, but as to the volume of ocean borne commerce, it will vastly increase. In the palmy days of the Italian Republics, the land-locked Mediterranean was the scene of ocean commerce; on the discovery of America it flowed out into the Atlantic, which has been the theater of recent development. But the commerce of the Pacific is just beginning. More than half the population of the world live in countries immediately contiguous to that ocean, and the majority of these are people just now waking to modern life and activity. Heretofore there has been no communication between the Pacific and Atlantic Oceans, except in the inhospitable water of Cape Horn. The Panama Canal changes that and the commerce of the Pacific will feel its quickening influence. In a general way, we can assert that as the Atlantic is to the Mediterranean, so is the present commerce on the Atlantic to the ancient commerce of the Mediterranean; as the Pacific is to the Atlantic, so will the commerce of the future be to the present Atlantic commerce.

THE PASSING OF SAIL VESSELS.

The use of steam in navigation is barely a century old. That century has witnessed the gradual development of the gigantic steamer of to-day, more than 900 feet in length, more than 90 feet in width, the floating home of between four and five thousand people, with a tonnage of nearly 50,000, of



THE MAURITANIA, A MODERN OCEAN LINER. Courtesy, Cunard Line.

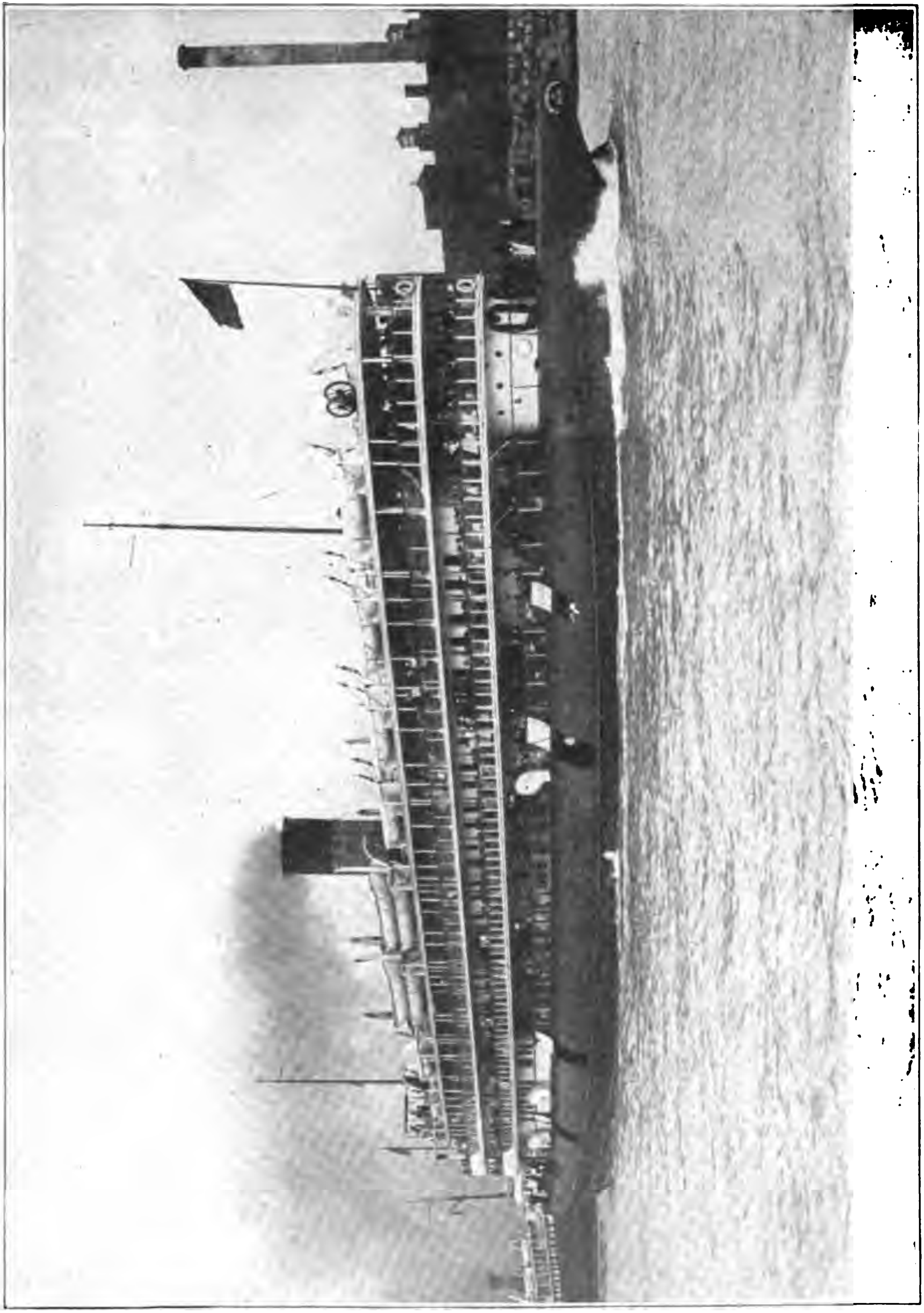
Courtesy, The Cunard Line.

SMOKING ROOM IN THE ACQUITANIA.

which 6,000 tons is coal for the voyage. But the sailing vessel is being crowded out. At present considerable less than one-fourth the total ocean tonnage of the world is sail.

LUXURY OF OCEAN TRAVEL.

Modern ocean travel is made very pleasant. The ships are over 900 feet in length, about 100 feet wide and have a tonnage of nearly 50,000 tons. To properly man such a ship as the Aquitania requires a crew of over 900 persons. It carries a fleet of 82 life boats and can accommodate between three and four thousand passengers. On reflection, we see we have in this ship a population sufficient for a good sized town. But it is safe to say that no town can show such luxurious homes as the temporary one of this floating population. There are sumptuous dining saloons, restaurants, smoking saloons, etc., fitted up regardless of expense. The sculptor, painter and engraver have been pressed into service. A gymnasium and swimming tank are provided for those who need exercise.



Courtesy Goodrich Transit Line.

THE CHRISTOPHER COLUMBUS, THE ONLY WHALEBACK PASSENGER STEAMER IN THE WORLD.

COMMERCE ON THE LAKES

Few even in America know of the vast volume of our lake commerce. The tonnage on our lakes is greater than the entire merchant marine of any nation in the world, except Great Britain and Germany. The commerce passing through the locks of the "Soo" Canal is now approaching 90,000,000 tons yearly, a slight further increase would be double the amount passing through the Suez Canal, the great ocean highway connecting Europe with the East. The Panama Canal is the only line of communication between the Pacific and the Atlantic Ocean, except far to the south off Cape Horn, or the tortuous strait of Magellan; yet it will doubtless be many years before the tonnage utilizing that canal will begin to approach the immense tonnage making use of the Soo. We must further reflect that the lakes are open to navigation only about nine months in the year, and that a very large tonnage does not pass the Soo at all, but passes through the Strait of Mackinac bound for Lake Michigan ports. A better measure of the lake commerce is the tonnage passing Detroit. We may expect this commerce to increase with the increasing business of the United States, for at the western ends of the lake are the immense fields, forests and mines of iron and other minerals, while vast railroad systems stretch away to the West to bring thither the enormous overland commerce of the Pacific states and central plains. At the eastern end of the lakes are the coal mines, the factories, the iron and steel mills of the manufacturing East with the great Erie Canal affording an outlet for the wheat, corn and agricultural products of the West. The lakes are the natural links between the two. We cannot overestimate the important part they have played in the development of the United States. Raw product in bulk—iron ore, copper ore, salt, lumber, grain, etc.—flow east, while the westward setting tide is the finished products of factory and mill. Coal, however, is an exception to this general rule, it being a raw product in bulk, flowing west. This national highway from Duluth to Ogdensburg, a total distance of 1,200 miles, is so thronged that there is scarcely a time when the lakes are open to navigation, that the mariner cannot see the hulls or smoke of many other ships within the horizon.

TIME OF DEVELOPMENT.

This immense commerce is a development of the last fifty years. To further it, the American genius has evolved a peculiar type of vessels and especially notable are the devices for loading and unloading vessels, by which unwieldy freight, such as ore and coal can be moved with a celerity undreamed a few years ago. As in ocean borne commerce, it is noticeable how certainly steam is crowding out sails. Even in the case of ships still rigged with sails, they are only auxiliaries, for the ships themselves are often towed by a steamer. The increase in size of ships is also noticeable. From 1890 to 1919, ships increased in length from 300 feet to 600 feet, in carrying capacity from 4,000 tons to 12,000 tons. The great business of the lakes is transport of freight. Everything is made subservient to that. There are, indeed, a few passenger ships as graceful in line and as complete in equipment as an ocean greyhound, but most of the lake craft are built with the sole idea to transport freight cheaply, and so are built on plans somewhat different from ocean craft, and lack the jaunty compactness of the salt water freighter, but to use the expressive language of a lake captain, "They deliver the goods."

THE WHALEBACK.

A distinctive type of ships is the "Whaleback" evolved to meet the needs of lake commerce. It is simply a long, blunt ended, steel hulk with rounded gunwales. From its appearance and behavior in the water, lake sailors have given it the expressive name of "pig," but its unsightly hull holds an enormous cargo. In fact, everything on the lake is designed for utility. The service demands the largest possible freight carrying capacity commensurate with safety, and in proportion to their size, they carry far more freight than ocean going vessels. But it must be recalled they do not have to take on such quantities of coal and supplies for their voyages.

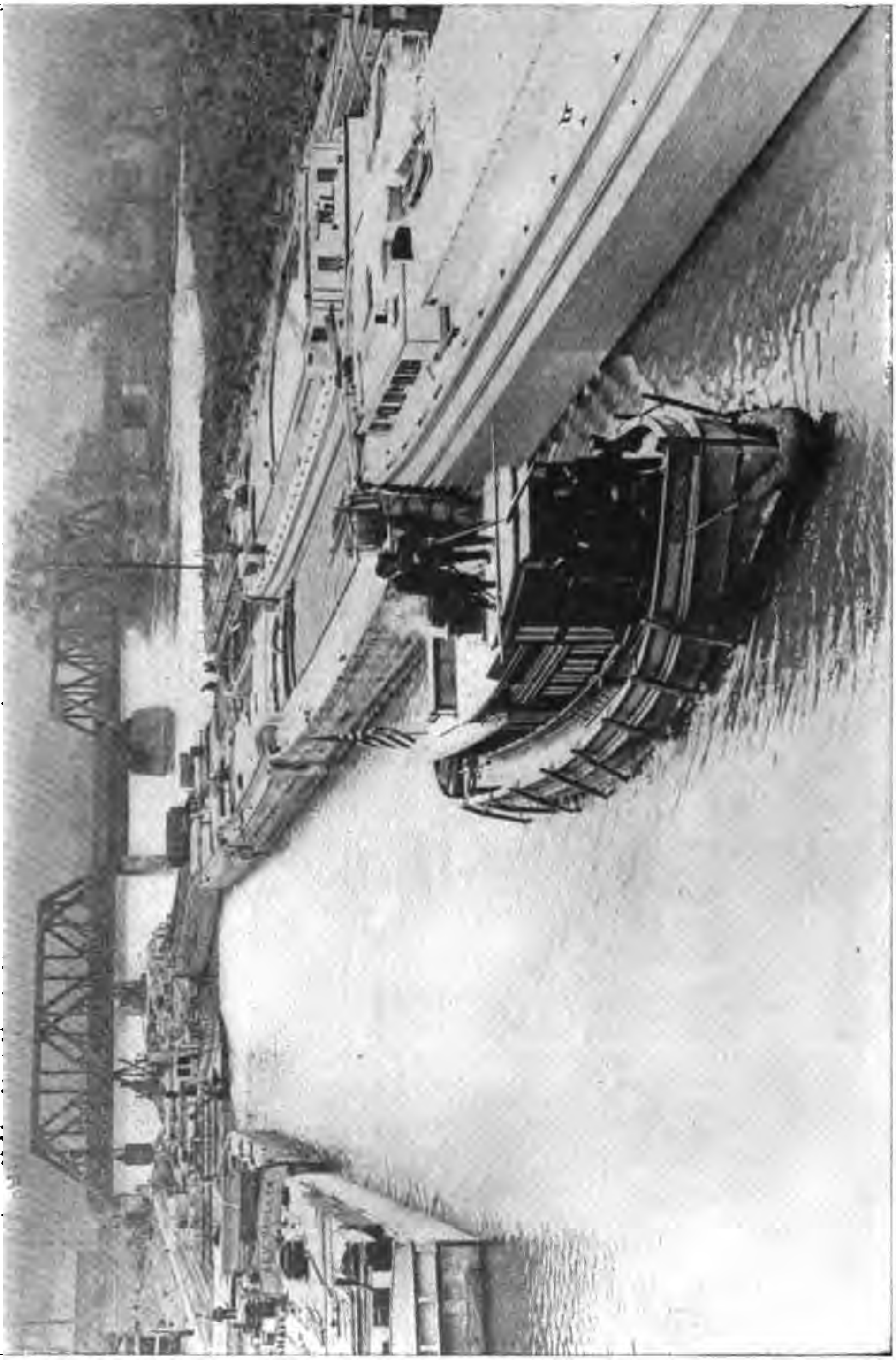
COMBINATIONS.

Combination of interests is also noticeable, and great fleets of vessels are designed for special lines of service. The principal special fleet is that of the United States Steel Corporation, which is more deeply concerned than any other in lake commerce. Their great success depends on their ability to transport vast quantities of ore from their mines in northern Michigan to their eastern mills. This transport is simply colossal, amounting yearly to about 60,000,000 tons. For this purpose the company own a line of ore steamers considerably more than one hundred in all (one hundred and fifteen some years ago) of the finest steel built lake freighters, and the company has developed special devices for handling ore. Nowhere in the world has the art of filling and emptying vessels reached the stage of perfection that it has at Duluth, Conneaut, and Buffalo. But this part of our subject will be more fully described in the section on Iron and Steel Industry.

Other great fleets are engaged in the transport of grain from Chicago and Milwaukee to Buffalo. This is known as the grain fleet. During the winter months, when this fleet is tied up at Chicago, the ships are converted into floating storage warehouses. The opening of navigation in the Spring is evidenced by the departure of this grain fleet from Chicago for eastern ports. Other fleets are devoted to the carriage of lumber, others of coal, and the Standard Oil Company has a fleet of its own.

AN AMERICAN INDUSTRY.

Such is a brief outline of lake commerce. It is a matter of just pride to all Americans that though our flag may be virtually driven from the sea, it is almost the only one in evidence on the lakes. It is safe to say that 90 per cent of the total lake commerce is under the flag of the United States. However, Canadian commerce, now only a small per cent of the total, is rapidly growing. This great flotilla of lake craft has been built in American ship yards and is owned and controlled by American capital. It is not out of place to remark that one type of vessel is not seen on the lakes, that is men-of-war, and no frowning fortifications, of any great extent, guard the approaches to our lake ports. The roar of Perry's guns in the memorable battle of Lake Erie was the last conflict of opposing naval vessels on the Great Lakes.



THE NEW ERIE BARGE CANAL.

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CANAL TRANSPORTATION.

All of the civilized nations of the world, recognizing the value of inland commerce, have built up systems of inland water communications by means of canals. Some statistics on this subject are of interest. Holland is but a small country, but relative to her area and population, she is in the front ranks commercially. That country has a system comprising 1,500 miles of canals, and one from Rotterdam to Amsterdam is a notable ship canal. France has been building up her canal system for the last three centuries. To-day that country has 3,000 miles of serviceable canals, on which she has expended $750,000,000. Germany has over 1,300 miles of canals connecting her rivers at commercially strategic points.

THE ERIE CANAL.

The most notable canal in the United States of the old barge type was the Erie Canal in New York. Only the Grand Canal of China exceeded its length of 400 miles. This is the canal on which the State of New York has recently expended $101,000,000 in improvements. Considering its length as well as breadth and depth it is the largest artificial waterway in the world. The depth of the improved canal is uniformly twelve feet, the width at the bottom 75 feet. Horse power on this canal is now superseded by towing barges, each of the towers is also a freight carrying barge, but they tow two or more barges behind them. Each barge will hold from 12,000 to 15,000 bushels of grain. This reduces the cost of transport very materially.

HISTORICAL RETROSPECT.

An historical retrospect is not out of place. For a quarter of a century, the Erie Canal was the greatest transportation route in the United States, and was a wonderful factor in building up trade between the West and the East. In fact, the development of the West was largely rendered possible by that canal, and it is admitted that it was the chief factor in making New York the greatest port in this country, of the world, in fact, where, in 1918, arrived and departed over 50,000,000 tons of merchandise. Without it, our development as a nation would have been far slower and our history might have been greatly different. Such considerations as these show the vast influence of trade routes on history, an influence as true now as in the days of Phoenician supremacy.

FUTURE OF CANALS.

In times past, the competition between canals and railroads as a rule ended in favor of the railroads, and fifty years ago it was quite generally asserted that canals as a prime factor in inland trade were a thing of the past, but it is now beginning to be seen that it is only necessary to develop canals to make them again of greatest value. This is what New York has done with her great canal; it is what Canada proposes to do with her canal connecting the Great Lakes with the St. Lawrence. And if Canada carries out her plans in this regard, on the scale proposed, the United States will have to some way meet that competition by still further enlarging and deepening the Erie Canal, making it a true ship canal, or the enormous trade of the rapidly developing Northwest will seek the markets of the world by way of the Canadian route. But American engineers dream of the day when not only from Buffalo, east, across New York will stretch such a ship canal, but that another one will be in operation from Chicago to the Mississippi River, using in this latter case the great drainage canal from Chicago to Lockport on the Des Plaines River and the Government canal from Hennepin to the Mississippi.

The volume of international trade is becoming so vast that railroads cannot continue to handle it all. There is a vast amount of necessary freight that must be moved cheaply, if moved at all, such as the coal, ores, timber, phosphates, nitrates, and potash, which are all essential to modern civilization. The future carrying trade of the world will be reorganized and the heavy slow work will fall upon waterways, natural and artificial, as a matter of course.

DRAINAGE CANAL, VIEW AT LOCKPORT, ILLINOIS.

THE CANALIZATION OF RIVERS.

In building up their waterways, the various nations not only construct canals, but it is recognized as a far-sighted policy to utilize the principal rivers of the land and improve the channel, so that they can be used for transport purposes. The principal nations of Europe have spent vast sums in thus canalizing their rivers. Both France and Germany have improved their rivers and corrected them by canals at strategic points. It is evident that this course is a great aid to internal commerce. In the United States every Congress makes liberal provisions for the improvement of the rivers of our country. The principal part of this improvement consists in building dams, which back the water up so that navigation is possible. Locks, of course, are provided at the dams to pass the boats to different levels. In other ways it is endeavored to make rivers, naturally of little value for transportation purposes, serviceable as routes over which to ship the heavy freight of inland commerce.

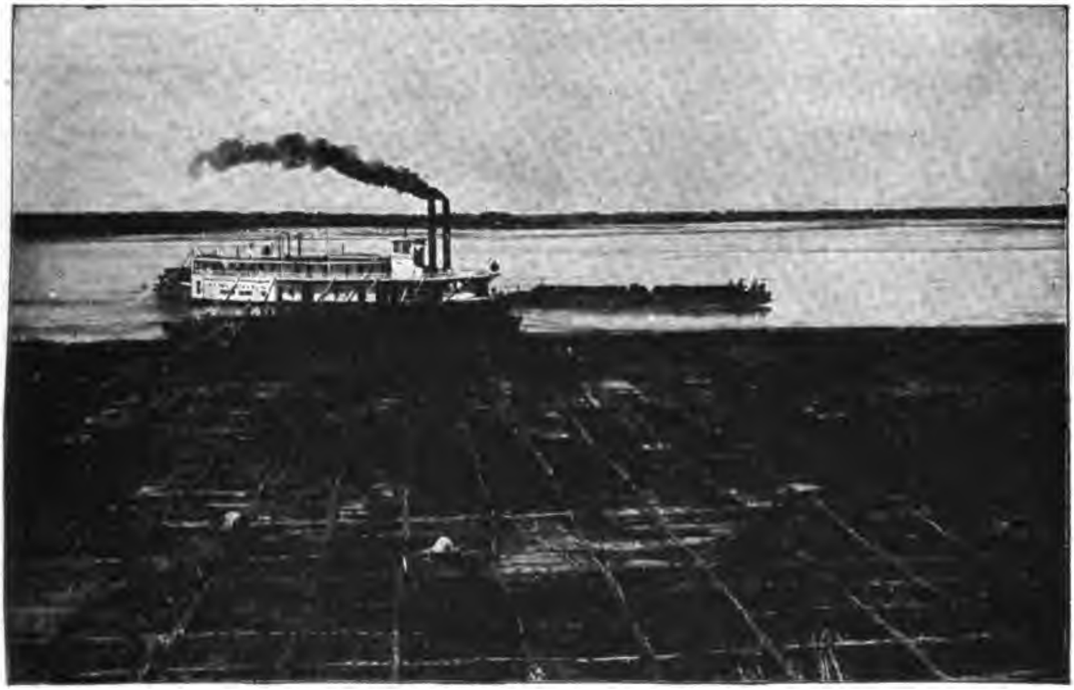
MISSISSIPPI RIVER IMPROVEMENT.

Vast sums have been spent and will continue to be spent in improving the Mississippi river. Jetties have been constructed at the principal pass of the delta to compel the current of the river to excavate a deep channel to the Gulf. The banks are protected at exposed places from washing. At Keokuk, Iowa, an enormous dam—an engineering marvel—has been constructed across the river. It is estimated the government could profitably spend $50,000,000 in improvement on this one river. The people of the Northwest are clamoring for a ship canal from Duluth, Minnesota, to the head of navigation on the Mississippi. It will not be long till the lumber, grain and iron and steel manufactures of that marvelous section will furnish all the tonnage such a canal could accommodate.

HOW THE UNITED STATES AIDS COMMERCE—REMOVING BENDS IN A RIVER.

GREAT SHIP CANALS.

Canals have passed through three stages of development. In the first stage, represented in all primitive countries they are primarily drainage ditches, only secondarily intended as channels of trade; in the second stage, they are, indeed, channels of inland trade, serving for the passage of specially constructed boats and barges, but they were fitted only to nourish the trade of the country, in which they were situated, they were not fitted to serve the purpose of international trade. In the third stage, on which the world has but recently entered, canals serve the purpose of international trade by affording passage for ocean going ships from ocean to ocean, or providing a means for such ships to reach inland cities, as is the case with the Manchester ship canal in England. We can say that in the first stages, canals were the capillaries of commerce; in the second stage they are the minor veins and arteries, which nourished important sections of the body politic; but in the third and final stage of development, they constitute the great arteries, which are guiding in pulsating streams the commerce of the whole world.



HOW THE GOVERNMENT PROTECTS THE BANKS OF THE MISSISSIPPI RIVER.

THE SUEZ CANAL.

The construction of the Suez Canal, opened to commerce in 1859, may be taken to mark the third stage in canal construction. It is 87 miles in length, and connects the Red Sea with the Mediterranean. The importance of this canal is evident when we reflect that by its means the vast tide of commerce between Europe and the East is saved the long detour around Africa. The far-sighted Pharaohs of Egypt dreamed of it, but as of something unattainable; it fired the imagination of Napoleon, but the difficulties of constructions were greater than he cared to undertake. It was finally built by the great French engineer, De Lesseps, who there gained renown, afterwards lost in the jungles of Panama. It originally cost about $100,000,000 but vast sums have been used in enlarging it. It now has a depth of 36 feet and is 134 feet 6 inches wide at the bottom. Being a sea level canal, no locks are required.

This canal has proved a great success financially and has greatly influenced advancing civilization. The tonnage passing through the canal increased from 650,000 tons in 1870 to about 50,000,000 gross tons in 1918.

SHIP CANALS IN EUROPE.

The Kaiser Wilhelm canal in Germany connects the Baltic and North Sea ports of the empire. The Amsterdam Canal in Holland was originally a barge canal, but has been enlarged until it is a ship canal. The Manchester Ship Canal affords a passage between the inland city of Manchester and the sea. This canal has five locks, by which ships are lowered 58½ feet. All these canals are ship canals of the third stage and have all exerted a great influence on the world's commerce.

THE SAULT STE. MARIE CANAL.

The American and Canadian canals at the Soo, though short, are typical canals of the third stage. The locks on the United States canal are the largest and busiest canal locks in the world, though not the widest or deepest. The tonnage utilizing this canal now reaches 90,000,000 a year, far more than that passing through the Suez. To properly appreciate the great influence of the Soo Canal, we must consider that no other means of transportation would enable us to bring the many millions of tons of iron ore from the mines of Michigan to the steel maufacturing centers of Ohio and Pennsylvania; if that ore could not be transported, our iron and steel industries would be puny affairs, and every industry in the United States would be depressed.

PANAMA CANAL

The Panama Canal constitutes the greatest artificial waterway in the world. In fact, owing to the bewildering special features of the canal, the colossal scale on which it is built, it is in a class apart from all other canals. The only one that can by courtesy be compared with it is the Suez Canal. The two canals agree in this: they both connect seas, they both separate continents, they both pierce isthmuses, they both serve the purpose of international trade. But with these considerations, all comparison ceases. The cost of construction of the Suez Canal was about one-quarter that of the Panama, though its length is about twice as great. The difficulties involved in its construction were but trivial compared with those vanquished in Panama. Suez is a sea level canal, Panama has six of the most massive locks in the world, supplied with a bewildering number of perfected details not known elsewhere, with protective devices before undreamed, and lifts and lowers its ships 85 feet. The Suez Canal was built across a low lying, sandy desert. Panama was constructed part of the way up the swampy, fever haunted jungle valley of a tropical river, down which poured, during nine months of the year, a raging flood, and then its builders dug a great trench, nine miles long, averaging about 100 feet deep, part of the way over 200 feet in depth, through the rocky backbone of the great continental divide, thence its way led across jungle wastes to the Pacific.

PRELIMINARY EFFORTS.

Few even in America know that for four centuries such a canal had been under consideration. It fired the imagination of

Spanish conquistadores, of whom Cortez was one. During the centuries of Spanish dominion, the court of Spain caused to be made survey after survey for the best route of a canal; in the days of Spain's decadence, other great nations of Europe dreamed of, and planned for, an Isthmian canal, knowing full well that whatever nations controlled such a canal would also control the commerce and politics of the Western World.

THE FRENCH ATTEMPT.

In a general way, all know of the vain attempt of a French company, aided, however, by France as a nation, under the lead of De Lesseps, who had successfully built the Suez Canal, to construct a canal in Panama. This attempt, in which thousands of lives were sacrificed and more than $250,000,000 of the savings of France were virtually squandered, resolved itself into a gigantic graft, ending in dismal failure.

THE CANAL ZONE.

Few know of the years of treaty making and gradual preparation before the United States was ready to begin its work. During that time a new republic—the Republic of Panama—was carved out of the territory of Colombia, and from that new republic, the United States secured a narrow zone of land, extending in general terms from Colon on the Caribbean shore to Panama on the Pacific, though neither of these cities is included in the zone proper. That zone, ten miles wide, except where it flares out to include the extended shores of Lake Gatun, is the newest possession of the United States, while the line of the canal is the center line of the zone. For that ribbon of land, we paid the Republic of Panama $10,000,000 and are to pay her $250,000 yearly as a sort of ground rent. Then there was required other years of effort to render our possession sanitary. The populous cemeteries of Mt. Hope and Ancon bear mournful testimony to the ravage of yellow fever in the days of the French attempt. But after great exertion the Canal Zone is now as sanitary as any part of our dominion.

THE ATLANTIC ENTRANCE.

The Atlantic entrance to the canal is the little Bay of Colon, known as Limon Bay, on the northern shore of Panama. It is of historical interest, for Columbus dropped anchor there in the fall of 1502, and the two towns (really one) of Cristobal Colon at the north entrance to the canal commemorate his name. On Cristobal Point there stands a statue of Columbus, with a crouching Indian maiden at his side. Its location is peculiarly appropriate. The admiral is gazing across the harbor at the blue expanse of the Caribbean Sea, as if noting the thronging steamers converging to the strait, which he was seeking, but which, denied by nature, a nation at his time unborn has constructed. Before us is the great Toro Point breakwater, which the United States government has built to protect the entrance to the canal. Near the starting point of that breakwater is one of the strongest fortresses in the world, provided with mighty guns to guard the ocean approaches.

THE ATLANTIC SECTION.

The canal starts at the south end of Limon Bay and takes a course due south seven miles to the works of Gatun. This constitutes the Atlantic sea level part of the canal. The excavated and dredged channel is 500 feet wide and 45 feet deep. The total amount of excavation in this part of the canal is about 48,000,000 cubic yards. It helps us to realize what these figures mean when we learn that amount of material would construct a rampart 35 feet high and the same in thickness two hundred miles long. On the way to Gatun the canal cuts across the old French Canal at Mindi and there is a notable difference between the small canal they were building and the imposing one the United States has constructed.

THE LOCKS AT GATUN.

At Gatun is one of the greatest pieces of constructive work in the world—the Gatun Dam and the magnificent double flight of three locks, not indeed the longest, but in their totality the most massive locks in the world. Their emplacement is in the hill on the eastern side of the dam. Each lock is 1,000 feet long, but the total length of all, including approaches, is about 3,500 feet—three-fifths of a mile. They constitute a gigantic stairway of three steps from the sea level to the level of Lake Gatun, 85 feet above the sea. Each lock is intended to lift ships 28 1/3 feet. Each lock is 110 feet wide, and the side walls are 81 feet in height. The locks are arranged in parellel flights. The center wall between is a huge concrete structure, 60 feet in thickness, with perpendicular sides 81 feet high. In constructing the locks, 2,100,000 cubic yards of concrete were used. This amount of concrete would build a wall ten feet in thickness, the same in width, 100 miles long.

The locks are opened or closed by the most massive lock-gates ever constructed. Each wing of the gate is of steel. They vary in height from 47 feet at the upper end of the upper lock to 79 feet at the lower end of the sea level lock. They are seven feet thick and sixty-five feet wide in each case. They weigh from 390 tons to 730 tons each. In building all the lock-gates of Panama, over 60,000 tons of steel were used. These gates are opened and closed by electric power. All manner of protective devices are employed, since a slight accident might put them out of commission. The gates themselves are in duplicate. A second pair is in position ready for instant use, in case something has gone wrong with the first one. In a similar way the lake level and sea level locks are protected by guard gates. A massive chain, capable of withstanding a tension of 120,000 pounds, is stretched across the approaches to the lake level locks. This chain is raised and lowered by electricity and until it is in proper position the electrical machinery operating the lock-gates will not work. Further still, at the lake entrance to the locks an enormous emergency dam, operated on a turntable device, is in constant readiness to be stretched across the channel, so that in ten minutes' time, in case of accident, a nearly water-tight dam is ready to stem the rushing current from the lake. Four immense towing cabs, working on the side and center walls, have the ship in absolute control and cautiously tow her from lock to lock.

GATUN LAKE.

Gatun Lake, to which steamers are raised by the locks, is one of the largest artificial bodies of fresh water in the world, covering an area of 164 square miles. The level of its surface is 85 feet above the level of the sea, and that is the summit level of the canal. The lake is formed by impounding the waters of the Chagres River, a river well known in Spain long before DeSoto stood on the banks of the Mississippi. To impound that water, the United States built Gatun Dam, the largest earth dam in the world. The dam is almost half a mile wide at its base (2,100 feet, to be exact), its gently sloping sides rise to a height of 115 feet, 30 feet above the surface level of the lake. At the crest it is 100 feet wide. Its total length across the Chagres Valley, which here is narrow, is about 8,000 feet, a little over a mile and a half, but part of that length is taken up by the spillway hill, a natural elevation. The amount of material dumped across the valley to form the dam is 22,000,000 cubic yards, material enough to build a Chinese wall around the state of Ohio, 12 feet high and 10 feet thick.

GAILARD CUT, FORMERLY CULEBRA CUT.

Gatun Lake itself forms the next 25 miles of the canal. That is to say, the steamers, after passing Gatun locks, can go under their own steam in a generally southeast direction to Gamboa Bridge. The lake channel is from 500 feet to 1,000 feet in width. Gamboa Bridge is at the southeast end of the lake, and here the famous Gailard cut begins. This is the narrowest part of the canal, extending in a south by east direction to Pedro Miguel, a distance of nine miles. The cut is simply an artificial canon, 300 feet wide at the bottom, 272 feet deep at the deepest point, with an average depth of about 100 feet. The water through the cut is 45 feet deep and stands at the same level as the lake itself; that is, 85 feet above the sea; for it is simply an arm of the lake. It was intended to make it 670 feet wide at the surface, but owing to slides, it is much wider at certain parts. Part of the way it is excavated through hard rock, but for the most part through a soft, easily decomposed material. Slides and all, 120,000,000 cubic yards of material were taken out of that nine-mile cut. That amount of material would build a rampart 40 feet high, 50 feet thick, 300 miles long—a very respectable amount of dirt to be taken from a nine-mile cut. If the Gatun Dam represents the greatest constructive work of man, this canon represents the greatest destructive work. It is another of the superlative degree features of the canal. Dam, lake and canon, all wonders in their way, represent the most audacious attempts of man to change the natural features of a country the world has ever seen.

PEDRO MIGUEL LOCK.

As it required three locks to elevate the steamers at Gatun to the level of the lake, 85 feet above the sea, it also required three locks to lower the steamers from the lake level to that of the Pacific. At Pedro Miguel the first step of the descending stairway is taken, and the lock lowers the steamers 30 feet. For various engineering reasons only one of the three steps in descent is here taken. The other two steps are two miles below and the charming little lake of Miraflores intervenes. The scenic surroundings of this lake are beautiful. From all sides stretch away the undulating hills and ridges of the isthmus—the same hills, with the same contour lines, dressed in the same many-hued mantle of jungle vegetation that arrested the pleased attention of the Spanish explorers four centuries ago.

MIRAFLORES LOCKS.

Miraflores Lake forms the next two miles of the canal and then we come to the two locks at Miraflores. The name, by the way, is a reminder of the days when the many flowers of the jungle graced the swampy banks of the Rio Grande, down whose valley the canal is constructed to the Pacific. Each of the locks at Miraflores raises or lowers ships using them 27½ feet, but another factor comes into play in the lower lock. The Pacific sends its tides up the canal channel to Miraflores and it makes a great deal of difference whether the tide be in or out. At times the lower lock has to raise or lower ships nearly nine feet more than at others, and we must allow for difference in density of fresh and salt water on different sides of the lower gate. So it is that the gates of that lock are the highest in the canal, being 82 feet high.

Courtesy of Pan-American Union.

ON LAKE MIRAFLORES.

THE PACIFIC SECTION.

From Miraflores to the Pacific at the town of Balboa, formerly known as La Boca—The Mouth—at the mouth of the old Rio Grande, a distance of a little over three miles, is the Pacific sea level portion of the Panama Canal, corresponding to the Atlantic sea level portion from Colon to Gatun. Owing to the great swing of the tide at Balboa, the canal channel has been dredged out to deep water, a distance of five miles. The total length of the canal from deep water to deep water is 50 miles. It is a fitting conclusion to this brief description of the canal, and to more forcibly impress us with a sense of its colossal proportions, to draw still another comparison. The total excavation in the fifty miles of canal from deep water off Colon to deep water off Balboa is about 242,000,000 cubic yards. The same amount of excavating (could it be made) would make a tunnel right through the heart of the world, 8,000 miles long, 14 feet in diameter, thus large enough to allow the passage of a New York subway train. Or yet again, the same amount of excavation that made the Panama Canal—fifty miles in length—would construct a canal 50 feet wide, ten feet deep clear across the United States.

At Balboa we are about twenty miles east of a line drawn due south from the Atlantic entrance at Colon. We are three miles from Panama, that city which was rich and powerful and well known in Europe a half century before St. Augustine was settled, nearly a century before Pocahontas saved the life of Captain John Smith, or a full century before the Pilgrims landed at Salem. We can not, however, see Panama from Balboa, because Soso and Ancon hills supervene. Before us, in the placid Bay of Panama, are the three small islands of Naos, Perico and Flamenco, which by treaty are now a part of the United States, and there the government is building immensely strong fortifications to guard the Pacific end of the canal.

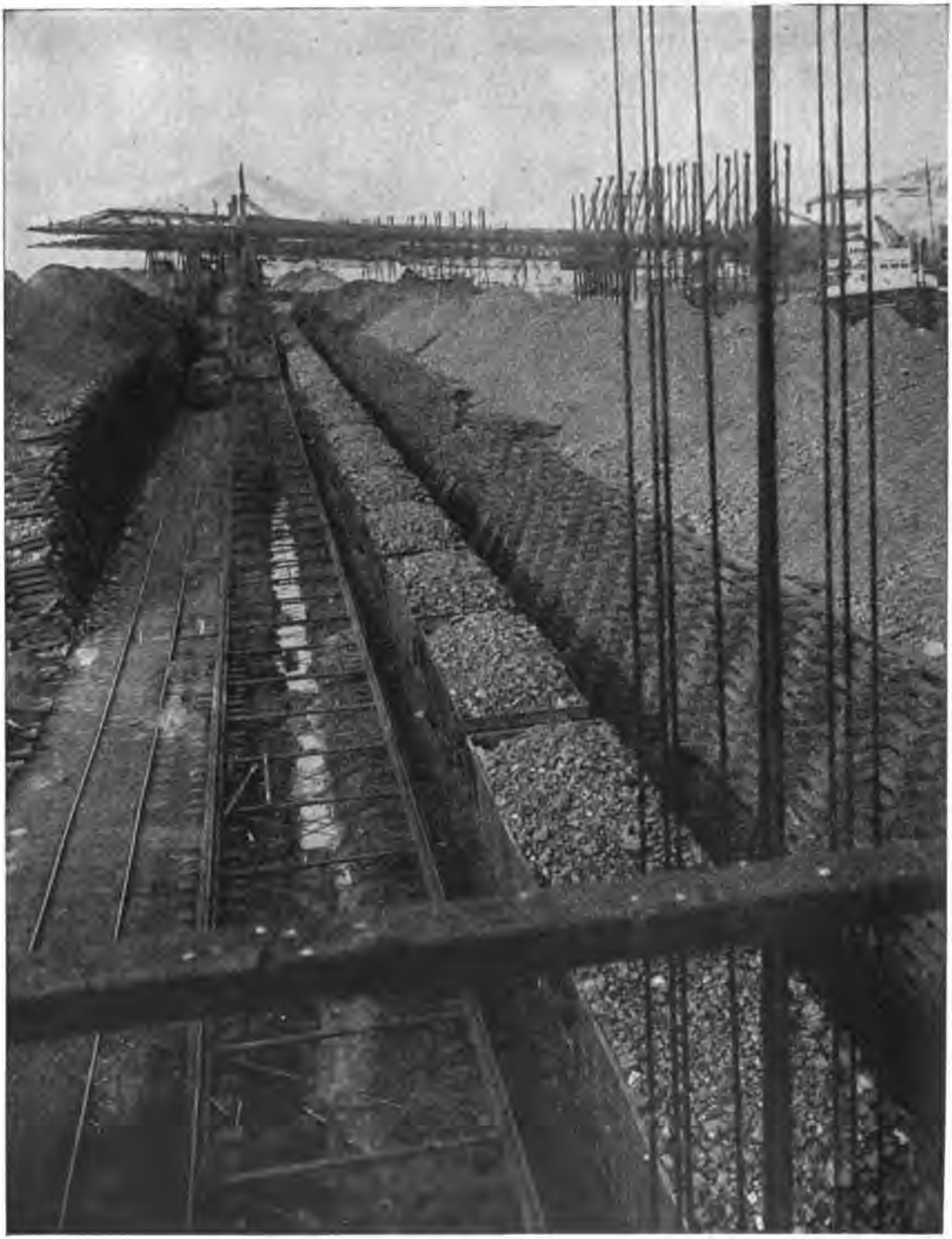
THE MISSION OF THE CANAL.

The influence the Panama Canal seems distined to exert is in keeping with its colossal size. The Canal Commission, summing up the results of a very careful investigation, assert "the benefit of an isthmian waterway will be felt in varying degree by more than half the nations of the world. In some regions this influence will be slight and indirect, or modify a small part of the trade, while in others it will affect the greater part of the trade, in still others it will affect the greater part of the commerce, and will work changes that will be almost revolutionary."

Every section of our country is to experience the vivifying influence of the more vigorous circulation of trade through this artery of commerce which we have opened across the isthmus. The commerce of the Pacific is going to be very large in a short time. Already that commerce reaches the huge total of about three billion dollars yearly; in the great development of the future this canal is going to be a great factor. It will set steamers sailing from all parts of the western Pacific to Panama, thence to waiting markets in our southern states, to New York and in many cases to Europe. From all seaports on the eastern shore of the Pacific it is going to set in motion new lines of steamers, sailing to our eastern ports and to Europe. All this means that the center of gravity of the earth's trade is about to shift from the Atlantic to the Pacific; a change which is as great as any known in history.

Courtesy of Pan-American Union.

THE "ANCON," THE FIRST STEAMER THROUGH THE MIRAFLORES LOCKS.



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PILES OF IRON ON DOCKS, BETWEEN STEAMERS AND RAILROAD, AT CLEVELAND.

THE MINING INDUSTRY

Transportation lines and means are employed mainly for the transport of commodities, and among the commodities, raw materials, the products of mines and forests and field, constitute the larger part. The mutual dependence of industries is apparent, for without iron, coal and timber transportation would still be confined to caravans and wandering traders. The mining industry depends upon transportation facilities, just as surely as modern transportation depends upon coal. Unless nature had stored within the earth the heat and light and energy of ages past in the shape of coal and oil and gas, modern civilization, arts and sciences, which have been nurtured by modern transportation, would be unknown. All descriptive terms for the present epoch, such as the Age of Electricity, the Age of Steam, the Industrial Age, are included in saying it is the Age of Coal; not, of course, meaning that coal is a product of this age, but that we have at last learned how to unlock nature's storehouse and utilize, though as yet imperfectly, the vast supplies of energy awaiting us.

COAL AREAS OF THE WORLD.

It is not known that nature is adding to her stores of coal at the present date, and it becomes an interesting problem to estimate the amount of coal available. But this can only be determined in a general way, with approximate accuracy for some sections such as the United States and Europe, but in general only a crude estimate can be given, because no geological survey has been made, as is the case in Central Asia, Africa and British North America. The United States is said to have about 450,000 square miles of territory underlaid with coal, though in about 20,000 square miles of this area the coal is at such a depth (3,000 feet) that it will probably never pay to mine it. China comes next with an estimated area of about 232,500 square miles. Manifestly in this instance the figures can not be accepted as possessing a high degree of accuracy. Great Britain has about 12,000 square miles; France, 2,500; Germany, 1,700, and Belgium, 500. These statements may be relied on. From that limited area an enormous tonnage is taken every year.

TOTAL COAL SUPPLIES OF THE WORLD.

From time to time we are asked to contemplate a gloomy state of affairs that will prevail when the coal of the world shall have been exhausted. The demand for coal is increasing at a very rapid rate. In 1900 the world mined about 800 million tons of coal. In 1918, 1,500 million tons were produced. In twelve years' time, then, the world's production of coal had increased ninety per cent. There is no reason to doubt this increase will continue, for the world's use of coal keeps pace with, and is a potent factor in advancing, the growing commerce of the world, and as yet only a small part of the world is awake to modern life. But according to the estimates of the executive committee of the Twelfth International World's Congress of Geologists that met in 1913, we need not worry.

In 1913 Great Britain mined 322,000,000 (short) tons of coal, but the committee estimated that country still had something like 180 billion tons to use. However, it should be borne in mind that the expense of mining may so increase that it will not be profitable to mine much of it. The United States mined in 1918, 685,356,000 (short) tons of coal (including anthracite), having increased its output 250 per cent since 1900, and the production is still rapidly increasing. These figures are eloquent testimony to the rapid increase of the transportation and manufacturing industries of the United States. It is interesting to compare the rate of increase in the United States with that of the world for the same time, which was only 70 per cent. But the committee to which we have referred kindly pointed out that we still have something like three and a half trillion tons of get-at-able coal in our portion of nature's warehouse, with unknown deposits, probably of vast amount, in Alaska. The committee also declared that according to the best of its knowledge and belief, nature has remaining in her various coal veins about seven and a half trillion tons.

These figures can not be comprehended by the human mind, so we may just as well say that the coal supplies of nature are virtually inexhaustible. In all probability, long before we shall have made noticeable drafts on nature's undivided surplus, we will have learned how to draw energy for all possible needs from the boundless supplies of interatomic energy everywhere around us, but of which, save for the reflective scholar, we are, at present, as ignorant as were the primitive tribes that hunted over the coal beneath their feet.

ANTHRACITE COAL.

There are two principal varieties of coal mined, anthracite and bituminous, or hard and soft coal. Nearly all the anthracite coal is obtained from a limited area, 484 square miles, in nine of the counties situated in the Susquehanna Valley, where at some distant time in the past, under strange geological conditions, nature produced that form of coal. There are other small areas in Colorado and New Mexico where anthracite is obtained, and we are told in general terms that Utah has as fine anthracite coal as Pennsylvania can boast of. Anthracite was the first form of coal extensively mined, and the first mine opened was in Schuylkill County, in Pennsylvania, in 1790. In 1820, 500 tons of anthracite were produced, and the first shipments were made to Philadelphia. It was soon discovered that anthracite was better and cheaper for iron smelting purposes than charcoal, then the only material used. This led to a great development in the iron industry, which in turn promoted the production of anthracite. Down to the year 1860 there was more anthracite than bituminous coal mined, but since that time bituminous production has far exceeded anthracite, which is now almost entirely used for fuel; its use in smelting iron has long since passed in favor of bituminous coal. Nearly 100 million tons of anthracite were mined in 1918—an increase of nearly 100 per cent over that of 1900.

BITUMINOUS COAL.

This form of coal is the fuel of the Industrial Age. It alone has rendered possible the great development of modern commerce. In the United States the production of coal has not only increased with, but it has been the medium which has rendered possible our wonderful advance in wealth and power. The amazing development of our railways was possible only because coal was at hand to move the trains. And by the same agent our supremacy in the iron and steel industry of the world has been won.

The following statistics as to the production of coal in the United States is not only interesting in itself, but it is a graduated scale on which may be read the inspiring story of national development in all that constitutes material well-being. The figures given are short tons.

YEAR.	TONS.	YEAR.	TONS.
1820....	500	1880....	76,157,944
1830....	318,072	1890....	141,229,613
1840....	1,785,574	1900....	269,604,027
1850....	6,445,681	1910....	501,596,378
1860....	16,169,736	1913....	570,048,125
1870....	36,806,560	1918....	685,356,000

Thirty states contributed to this total production. Pennsylvania is far in the lead with a total production, including anthracite, of 283,185,000 tons, thus about forty per cent of the total amount mined. West Virginia mined 91,350,000; Illinois, 91,263,000, and Ohio, 46,464,000.

An analysis of these figures, especially from 1870 to 1913, shows how true it is that the production of coal has kept pace with the development of our leading industry, whether you have in mind development of railroads, increase in production of iron, or growth in manufacturing. The connection between coal and railways is especially close. In the first place, railroads require a vast amount of iron and steel to build and maintain, and fuel to run them is required on a very large scale, and most important, the various industries that follow the establishment of railroads create a market for more coal. The fact that in 1918 there were transported by rail 400,000,000 tons of coal and coke shows what the importance of coal in the freight-carrying business of railroads is.

FUTURE PRODUCTION OF COAL.

Vast as was the world's production of coal in 1913, imposing as are the figures of the amount mined in the United States for 1918 no one need doubt future production will greatly exceed the present. In the entire world there are continents waiting the dawn of modern industrial life. In the United States there are vast sections waiting the coming of railroads, factories and the busy scenes of modern days. At present one state in the Union produces nearly half the coal. There are vast areas in our country which are known to be rich in coal where only a beginning has been made. Alaska is not only going to furnish immense supplies of coal, but it will require vast amounts for its railroads and varied industries. Of course, as time advances, civilization is going to make greater and greater use of waterpower wherewith to furnish energy, but future needs will be so great that this fact will not greatly change our dependence on coal.

POWDERED COAL.

There has but recently been perfected a process of using coal which opens up possibilities in the way of utilizing poor grades of coal, of which vast deposits exist, especially in the West, which have been considered almost worthless. The coal is powdered, then blown with great rapidity in connection with a blast of hot air into the combustion chamber, on the same principle that crude oil is used. Air and coal powder make a dangerous explosive compound, but the union is only made the moment of passing into the combustion chamber. Remarkable results are attained even with very poor grades of coal. The economies of handling are so gratifying that this method will probably be greatly developed in the future, which in turn will make profitable the immense deposits of low-grade coal in the West.

MINING COAL.

In 1918 there were employed in the coal mines of the United States nearly 700,000 men. It is important to know how this army of men perform their work. The process by which the coal is mined is an interesting one. Down deep in the earth stands a grimy miner. He is dressed in homespun clothes, and upon his head is a cap, resembling a helmet, to which is attached a small lamp, known as the safety lamp. This throws a faint gleam around him and permits him to see the black walls against which his efforts are being directed. The lamp, which rests upon the peak of the cap of the miner, is the invention of Sir Humphrey Davy, and is so constructed as to prevent explosion. However, the Wolf lamp, a recent invention, is far the better lamp. It extinguishes itself in the presence of fire damp, or of explosive mixture, or in case it should be overturned; it is provided with a magnetic lock that can not be picked and so cannot be opened by a careless miner, and it has an igniter by which it can be lighted without opening it.

GANGWAYS AND BREASTS.

With pick and shovel the miner breaks down the coal, gradually enlarging the subterranean chamber in which he is working. At stated intervals, giant powder is used to blast out great chunks of coal, which fall around the shaft in great profusion. Miners, in most mines, are compelled to use both vertical shafts and horizontal tunnels. The passages entering the seams at the working level from the shafts are called gangways. They may run in any direction, toward the seam, around it, or through it, and from these other passages are driven off, known as breasts, in which the miners work. In anthracite mines the gangways are often ten and twelve feet wide, and from twelve to twenty-five feet high, while the breasts are from twenty to thirty feet wide and separated by intervening walls or pillars from fifteen to seventeen feet thick. The breasts and gangways are supported by heavy timbers, surmounted by cap pieces and cross pieces and set at intervals varying with the nature of the deposit. At present there are over 7,000 miles of tunnels in the anthracite mines. If the first opening be in the side of the hill, it is some distance before it is necessary to sink a shaft. From the shaft the gangways radiate in whatever direction the coal measurers lie, and at different levels, so that work may be carried on in many places at the same time. Tracks are laid in all these tunnels, and little tram or dump cars are run back and forth to carry the coal to the surface. When they reach the shaft, they are placed on powerful elevators and brought to the surface of the earth.

MOTIVE POWER.

Horses and mules are used to haul these cars in the great majority of cases, but in hundreds of mines a small electric locomotive is used. These locomotives vary in size anywhere from two to twenty tons in weight, which is about the largest that can be profitably employed, on account of the limited dimensions of ordinary mine entries, and light weight of rails. In some coal mines the cars are gathered or collected from the working faces of the room by mules or horses, though in some low-veined mines, where it is necessary to use very small cars, they are pushed between the working faces and the room necks by the miners themselves. They are then collected by locomotives and hauled in trains to the tipple or shaft bottom. Electric headlights and mechanical brakes are used, the current being taken from an overhead copper trolley wire.

RECENT IMPROVEMENT IN MINING OPERATIONS.

Inventions of recent years have expedited and lightened considerably the work of the miner. Steel drills driven by compressed air, well-ventilated shafts, automatic dumping cars and other improvements have made his work lighter. There are now very effective machines for mining coal. The older forms of the machine were of the pick or puncher type, run by compressed air, but now electric coal cutters of the chain type, driven by electricity, have come into quite extensive use. The pick machine, driven by compressed air, strikes about 200 blows per minute. They can be used in mines where the narrow conditions of room and floor do not permit the introduction of chain breast machines, and they obviate the danger of explosion that might arise from sparking if a motor-driven machine be employed. But the advantages are with the modern chain machines, where they can be used, and such important improvements in their construction have been made that they can be used in very thin veins where it was formerly thought they were not available. The use of electric rotary drills and augers is quite common, and appears to be thoroughly successful. These drills are used for boring holes into the coal for shooting it down after it has been undercut. Electric percussion drills are also in use. How effective they may be is shown from the fact that a powerful hammer blow is struck at the rate of from four to five hundred blows per minute. In 1912 nearly 40 per cent of the total coal mined in the United States was machine mined, and this explains the very considerable amount daily mined by the average miner at present, over the amount mined in former years.

SORTING COAL.

In a great coal "breaker" there is much noise and plenty of dust. There are rickety sheds, inclined planes, screens and chutes, without number. The loaded cars, right from the mines, reach the breaker high in the air, and are tipped so that they dump their cargo into chutes, provided for that purpose. As the coal rattles down through the winding way provided for it, the various chutes sort the grades and sizes, and when it reaches the bottom it falls into bins or coal dumps and is ready for the market.

THE "BREAKER BOY."

In preparing coal for the market, the "breaker boy" plays an important part, for it is he who stands guard and removes each piece of slate from among the coal. The breaker boy or coal picker gets his first lessons in mining by sorting out the slate. The miners in many of our mining districts are foreigners, with but little education, and this class of laborers forms one of the most difficult problems to deal with.

THE COKE INDUSTRY.

In stating that bituminous coal was largely used for smelting purposes, it should be understood that the coal is first changed to the form of coke; that is, coal from which the bitumen, sulphur or gas has been extracted by roasting in a kiln or oven, or by distillation, as for gas. It is largely smokeless and gives an intense heat, rivaling anthracite, and is far cheaper. The growth of this industry is something wonderful. It has grown with the growth of our iron and steel industry. In no other way could the United States have won the preeminence in such manufacture. Its development is shown by the fact that we manufactured 17,561,222 short tons in 1900, but in 1918 this amount had grown to 49,648,000 short tons, valued at more than one hundred million dollars.

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COKE OVENS.

COKING COAL.

It is not all bituminous coal that can be used to good advantage in the production of coke. At present the center of the coking industry is the Connellsville section in Pennsylvania, which extends from a point near Latrobe, in a southwesterly direction, a distance of about forty-two miles, and covers an area of about 147 square miles. Other sections furnishing coking coal are the Warrior River basin in Alabama, the Tug River mines in West Virginia and the Pocahontas mines in Virginia. Other sections are known, especially in Kentucky, that await a great development in the near future. It is claimed by mining engineers that there is enough high-grade coking coal in the United States to supply the furnaces of the world for centuries to come. In this respect, also, nature has made ample provisions. The location of the great vein of coking coal, from eight to nine feet in thickness, at Connellsville has made Pittsburgh the center of our steel industry.

In no other section has coal mining been more scientifically developed. The shaft pierces hundreds of feet of rock that but a brief time ago would have been thought too great an obstacle to overcome. The mule is largely replaced by enormous engines. Natural drainage has been replaced by huge pumps; natural ventilation, by powerful fans; the hand dump by the steam ram or pusher, and the lard-oil torch, by the electric light. Single entries are replaced by double and triple entries, and they and the rooms and pillars are laid out and driven with mechanical precision.

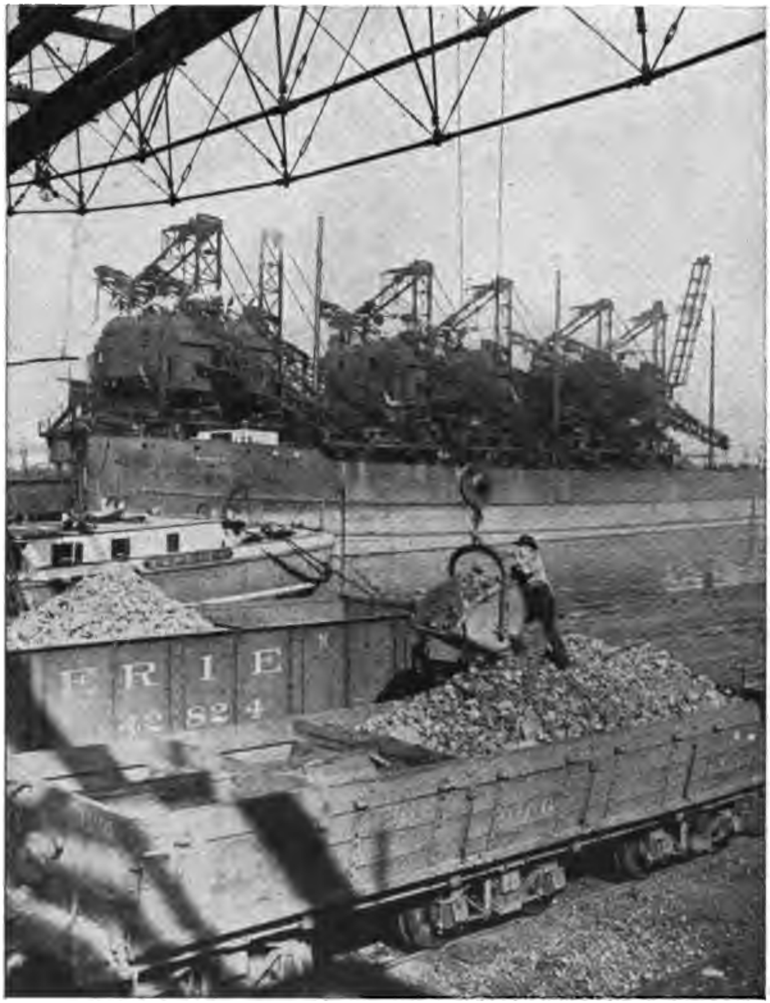
COKING MACHINERY.

The mechanical appliances used in the manufacture of coke have been improved so that virtually all the work from the mine to the railway car with the finished product can be carried on by machinery. The coke is drawn from furnaces where the coal has undergone the roasting or charring process, by ingenious mechanism which works like a great iron hand on the end of a long steel arm. This is carried on a heavy car, which runs back and forth on a railway track in front of the row of furnaces. An engine mounted on the same car furnishes the power for this giant hand, which rakes the coke from the furnace into a long trough. An endless belt in this trough forms a carrier, connecting with another one of the same kind, by which the product is loaded directly into the cars for shipment.

As a result of all this development, the Connellsville coke section is the location of enormous coking plants, having from 700 to 1,000 blazing ovens under one management, turning out from 100 to 150 carloads of coke daily, the total production now approaching many million tons yearly, with the probability of further and still greater increase in the future. Like a wealthy young spendthrift, the United States produces most of its coke by a process which wastes the immensely valuable by-products, such as gas, naphtha, benzine and coal-tar products generally, which other nations save. A reform is, however, being introduced, and when the necessity of saving becomes more apparent the beehive ovens now so largely used will probably be replaced by other forms, which allow the saving.

HANDLING COAL.

In order to handle coal economically at important shipping points, machinery for loading and unloading is employed. The mere volume of material to be moved has compelled the employment of labor-saving devices which have been so brilliantly employed in the handling of iron ore on the Great Lakes. The Hulett unloader is a machine invented for handling iron ore, but it is also employed in handling coal. The immense clam buckets of this machine will go down into a car or the hold of a vessel and pick up eight tons, carry it high in the air and discharge it into a hopper or conveyor. One of these machines can handle from 450 to 500 tons of coal per hour. It can unload a 12,000-ton ship in a day.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HANDLING COAL AND ORE.

In the foreground there is the bucket handling; in the rear view the new unloaders that will pick up eight tons at a dip.

But coal is also handled in carload lots. The loaded car is pulled up a steep incline to a cradle big enough and strong enough to receive and hold fast the car and its load. The car is clamped in position and then cradle and car are lifted and turned sideways and the load is thus dumped into a chute from which gravity takes it to the hold of the waiting ship. An entire car can thus be emptied in a minute's time. It is such appliances as these that have made New York and Norfolk the greatest coal-shipping points in the United States, with facilities for handling thousands of cars per day.

IRON AND STEEL INDUSTRY

It is impossible for an American to read the story of the development of the iron and steel industry in the United States since the opening of the present century without a feeling of exultation. No set of figures more convincingly show the commanding position we hold in the manufacturing world or our undoubted ability to maintain the lead we have so lately won. They tell of a sudden, unparalleled expansion in national greatness in keeping with our vast railway mileage and our enormous tonnage of coal. A most interesting parallelism is disclosed, taking into consideration world figures; in 1918 we had about forty per cent of the railroad mileage; we mined about forty per cent of the total amount of coal produced; and lastly, we smelted just about forty per cent of the total amount of iron manufactured.

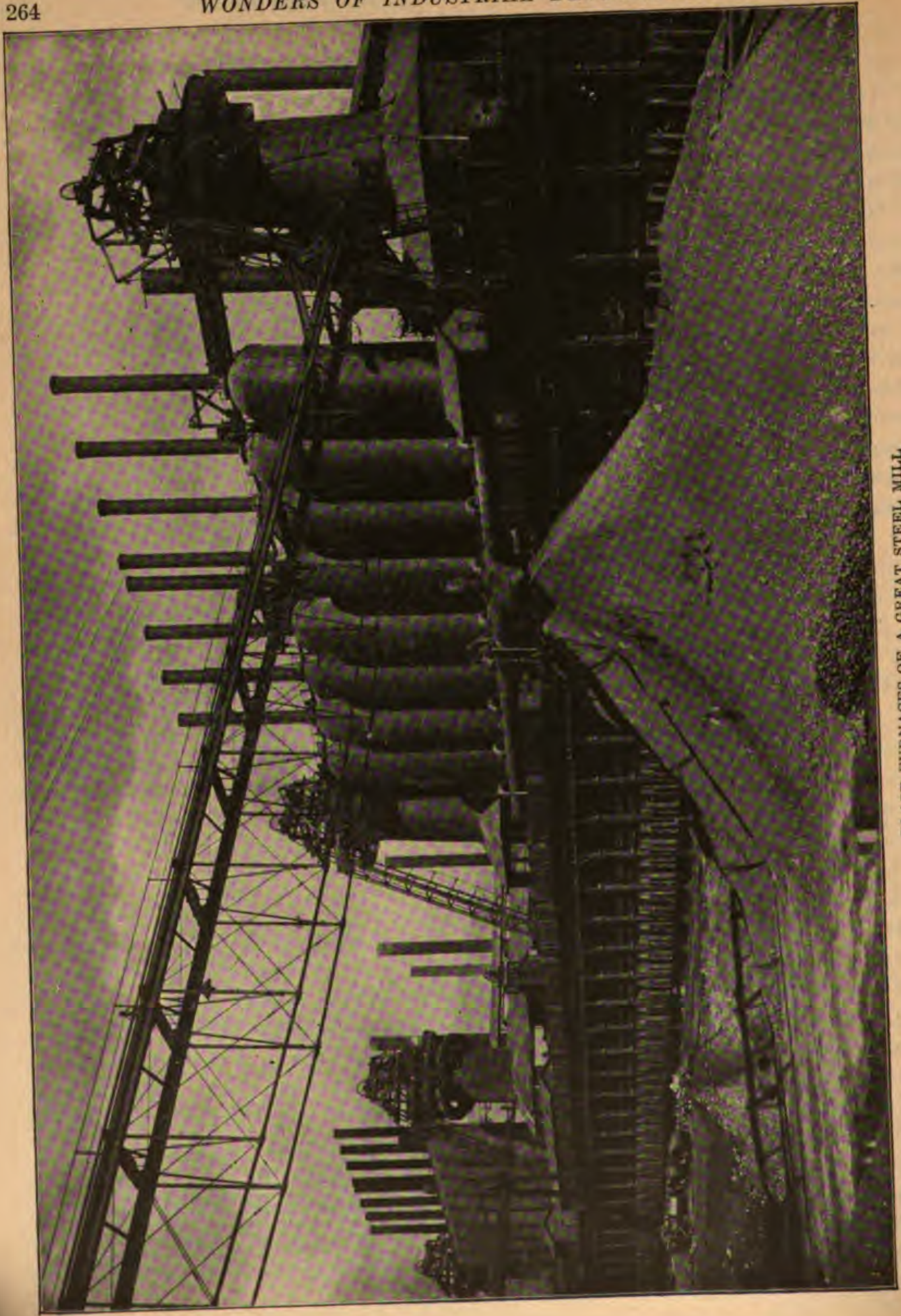
IRON ORES.

Everyone knows that nature does not produce iron in a pure state. An iron mine is simply a deposit of iron ore, of which there are several different varieties. Hematite ores are principally oxide of iron, and are known as red and black hematite ores. Ordinary iron rust is pure red hematite, so when we read of the red hematite deposits in Minnesota we can form a good idea of what it looks like. This is by far the most common form of iron ore, and is the principal one in the Lake Superior section. It also occurs in immense quantities in the southern iron section, and westward in Colorado. Magnetite iron ores are those in which the oxide is magnetic. It is a very valuable ore, because it produces a superior iron. The supplies of this ore were formerly limited in the United States, but only recently immense deposits, probably aggregating hundreds of millions of tons, have been discovered in the Cuyuna range, one hundred miles from Duluth in Minnesota, one of the most important bodies of ore ever discovered.

The distribution of iron ores throughout the United States is general. There is no state in which iron ore is not found, and in considerable quantities, but they are not all available. In some cases the ores are too lean; that is, carry too small a percentage of iron; in others they are combined with deleterious substances like phosphorus and sulphur, or they are too far from smelting fuel, or are too scattered. Many of these present difficulties may be removed in the future by better means of smelting or by extension of transportation facilities bringing the ore and the fuel together. In 1918 iron ore was mined in twenty-eight states of the Union, which produced about 75,000,000 long tons. About 80 per cent of this amount came from the Lake Superior district.

IRON ORE IN THE UNITED STATES.

The increase in the products of iron and consequently of iron ores in the United States had been at such a rapid rate that fears have been expressed that in a comparatively short time our supply of ore would be exhausted. But in this respect, as in coal, nature has made such ample provision that there is no occasion for immediate worry. In 1908 the United States Geological Survey estimated that we had nearly five billion tons of available iron ore in our known mines. It is thought that in the Lake Superior section of the country there



BLAST FURNACES OF A GREAT STEEL MILL

is about three and a half billion tons remaining; but vast bodies of ore are constantly being discovered. Wyoming, Utah, Washington, and California have mountains of high-grade ore, needing only railroads, furnaces, mills, foundries, and an adequate market for the product, all of which will come in time. Among recent discoveries we note the enormous deposits—totaling hundreds of millions of tons—of magnetite in the Cuyuna range. Undoubtedly other deposits of vast amount will be discovered in other sections, but there can not be another such combination of favorable circumstances as is present in the Lake Superior section.

LOCATION OF IRON AND STEEL MILLS.

We can not expect the same section of country to be underlaid with both coal and iron in quantity. Even nature is not thus prodigal of her riches and notable deposits of iron and coal are separated by considerable distances. Pennsylvania, which produces nearly 300,000,000 tons of coal a year, is not particularly noted for its iron ore. The Lake Superior section, possessing the greatest iron deposits in the world, has no coal. Iron ores and coal, both bulky freight, must be brought together to manufacture iron. Between the ore wealth of the Northwest and the equally marvelous coal wealth of the East is the chain of Great Lakes, now affording the cheapest freight transport in the world. Heretofore the largest part of the western ores have moved east to the coal fields, and Pittsburgh has been the center of our industry. It may not always be so. Coal may move west to the ore fields, or they may meet at intermediate points. What is described as being the largest and most up-to-date steel mill in the world is located at Gary, Indiana; another very extensive plant is at Joliet, Illinois; and what is intended to be one of the most extensive and in every way most complete mill in the world is building at Duluth. It will manufacture high-grade iron from the magnetite of Cuyuna range. It is true economy to furnish freight west for the ore fleets that have steamed east from Lake Superior ports, and remarkably low freight rates result.

LAKE SUPERIOR MINES.

The development of iron mining in Lake Superior sections is one of the marvels of this Industrial Age. It was barely 20,000,000 tons at the beginning of the century. That production was regarded as wonderful, but by 1918 it had increased 300 per cent and the end is not yet in sight.

The principal mines are located in ranges of which the most famous are the Menominee, Marquette and Gogebic ranges in Michigan; the Vermillion, Mesaba and Cuyuna ranges in Minnesota. The mines in these ranges are from twenty-five to one hundred miles from Lake Superior, and at present there are ten separate railroads leading to lake ports. In the Mesaba and Cuyuna ranges the ore is mined in the open—that is to say, the deposits are in thick, horizontal strata, overlaid by a shallow bed of loose glacial drift (or soil), and it is only necessary to strip that layer off by steam shovel, or in some cases by hydraulic means, like mining operations in the West, and then simply load the ore on cars. Every possible economy in the way of handling the ore has been introduced.

THE DOCKS.

So perfect is the machinery for shipping that from the moment the ore leaves the mine until it comes from the mill, as steel rails or other products, hand labor scarcely touches it. Every step in the long process is worked out by machinery. The ore, which resembles loose red earth, is scooped up by immense steam shovels that in an hour's time will load an entire train of dump cars. Each scoop of the shovel brings up about five tons of the ore. The shovel simply travels back and forth in front of the cut, loading the cars in adjacent tracks. The train loaded, it starts for the ore docks at one of the ports. The docks are built far out in the lake. They look like an unfinished bridge, one end resting on solid ground. They are so large that the greatest vessels lie hidden along their sides; they are so high that the ore trains on top look like rows of children's blocks.

The ore cars have openings in the bottom so that when the train runs out on the elevated dock the ore can be dumped into bins, from which long metallic chutes lead down to the vessel. These facilities are so perfect that at Duluth from one dock 165,000 tons have been loaded into sixteen steamers in one day's time. There are five miles of these docks at the various Superior ports, and since one dock costs a million dollars to build, we can estimate the total capital invested in docks alone.

OTHER INTERESTS BESIDES THE STEEL CORPORATION.

A great deal of capital is required to successfully prosecute iron mining. The unlimited means at command of the United States Steel Corporation enable them to conduct their operations on such a scale that they produce steel and iron at less cost than in any other country, though prices paid are higher. It is a mistake to suppose they are the only parties interested in the Minnesota ore mines. Neither must we understand that all mines in that section are in the open, though the mines in the Mesabi range are worked that way. But a great many mines are what we ordinarily understand by "mines," underground workings, and require the usual methods and have to contend with the usual difficulties, timbering, pumping, etc. Some of them have miles of drifts and cross cuts intersecting and dividing the ore body, and there are electric locomotives, tramcars and other auxiliaries in mining. According to the State geologist the United States Steel Corporation controls only about 25 per cent of the ore section of the state, but they are by far the best organized for business.

MOVING A CITY.

The open cuts, or mines, are so extensive that in the Cuyuna range the town of Hibbing, Minnesota, a city of ten thousand, with churches, schools, banks, etc., is moving to a new townsite, because underneath its present location is an immense bed of magnetite into which the steam shovels are eating. It might be stated that one entire township six miles square is supposed to be underlaid with a deposit of this valuable ore five hundred feet thick. In time to come, the total excavations in that one township will doubtless far exceed the total excavation for the Panama Canal. In fact, Gailard cut will be a small affair in comparison.

From the docks the great fleet of steel vessels take the ores east to Chicago, Milwaukee, Gary, and especially to Lake Erie ports—Cleveland, Ashtabula, Conneaut and Buffalo. Unloading machinery is as fully developed as loading machinery at the western end of the trip. The unloader consists of a massive walking beam, to the outer end of which is pivoted a vertical arm, at the bottom of this arm is a clam-shell bucket capable of lifting ten tons of ore at one trip. As the vertical arm descends into the hold of a vessel, the two halves of the bucket open out and as they close they "grab" their ore load, which is lifted and moved with ease. Three men with one of these machines can move 300 tons of ore in an hour. As a result of all these economies, ore can be mined, moved to the docks, loaded on to steamers, transported by lake 1,000 miles, unloaded, and placed on cars for less than two dollars a ton.

IRON AND STEEL MANUFACTURING

America, with its great mountains of iron ore, furnishes most of the steel of the world for bridges, high office buildings, railway rails, wire, and the manifold forms of steel and iron which, commercially bring thousands of dollars to the manufacturers. Let us see how crude iron ore changes its shape and quality at the hands of man.

THE CUPOLA MAN.

In an iron foundry the "cupola man" or "melter" is a person of considerable importance, for he "makes" the iron, and the presence of more or less of this or that metalloid in his pig iron, too much sulphur in his coke, too little air coming through the blast-pipe, or a heavy atmosphere, are circumstances beyond his control, which may turn all his plans to naught.

THE CUPOLA.

The cupola is the vertical, cylindrical-shaped furnace, in which the iron is melted from "pig" or scrap, to be cast in the sand molds, into all of the different forms and shapes taken by cast iron. The real bottom of the cupola is made of sand, and this sand bottom rests on a false bottom which is made of iron, and so swings on heavy hinges that it may be dropped, emptying the cinders on the floor of the foundry. This false bottom is held in place by a heavy piece of wood, which stands on the solid foundation that supports the legs of the cupola. The "tap-hole" of the cupola is the opening through which the molten metal runs into the "spout" and then into the ladle. It is generally about four feet above the floor of the foundry, for it must be high enough to clear a large ladle, to catch the iron. In the back of the cupola is the cinder hole. This hole is used to tap the cinder and to give the alarm should the molten metal rise to the "tuyere" line.

THE TUYERE.

"Tuyeres" are the openings for admitting the air blast into the cupola, and they are generally placed high enough from the bottom to give a bed of molten metal, weighing from 1,500 to 2,000 pounds. The air, driven by a revolving fan, is carried

DRIVING NAILS BY MACHINERY.

to the cupola through the blast pipe. Around the base of the cupola and on a line with the tuyeres, is the "wind box," which carries the blast to the tuyere openings. The "charging floor" is a platform on which the coke, pig iron and scrap iron are piled, and on which the men stand when charging the cupola. The pig iron is usually broken into short pieces to facilitate handling, and to expose more surface to the heat.

UNLOADING ORE AND LOADING FUEL
LACKAWANNA ORE DOCKS, BUFFALO, N.Y.
DETROIT PHOTOGRAPHIC CO.

UNLOADING ORE AND LOADING FUEL, LACKAWANNA ORE DOCKS, BUFFALO, NEW YORK.

CHARGING THE CUPOLA.

To charge a cupola is to place in it alternate layers of fuel and iron. Before charging, however, the cupola must be heated, and a fire of coke is started. The cupola man places on the bottom of the cupola a bed of coke and, frequently, a certain proportion of hard coal in large lumps, with the coke. This bed is placed there as a reservoir, and is supplied, at intervals between charges of metal with fresh fuel. When this bed is burnt through and the cupola is heated, a fresh amount of coke is thrown in through the charging door, and then a layer of pig iron, or a layer of pig iron and scrap iron, in varying proportions, is put on the coke. More coke is then thrown on top of the iron and then another layer of metal is put in, and these alternate charges of fuel and metal are put into the cupola until it is full. Then the blast is turned on. When the iron becomes heated it gradually melts. There is a peephole, through which the cupola man can see when there is a quantity of molten iron, and when there is enough the tap-hole is opened and the liquid metal, throwing off a shower of sparks, flows out into ladles, to be poured into molds. The ladles vary in capacity from 50 pounds for the smaller ones, to 12,000 pounds for the big clay lines,—"bull" ladles,—which are handled by traveling cranes and machinery.

CHEMICALLY PURE IRON VALUELESS.

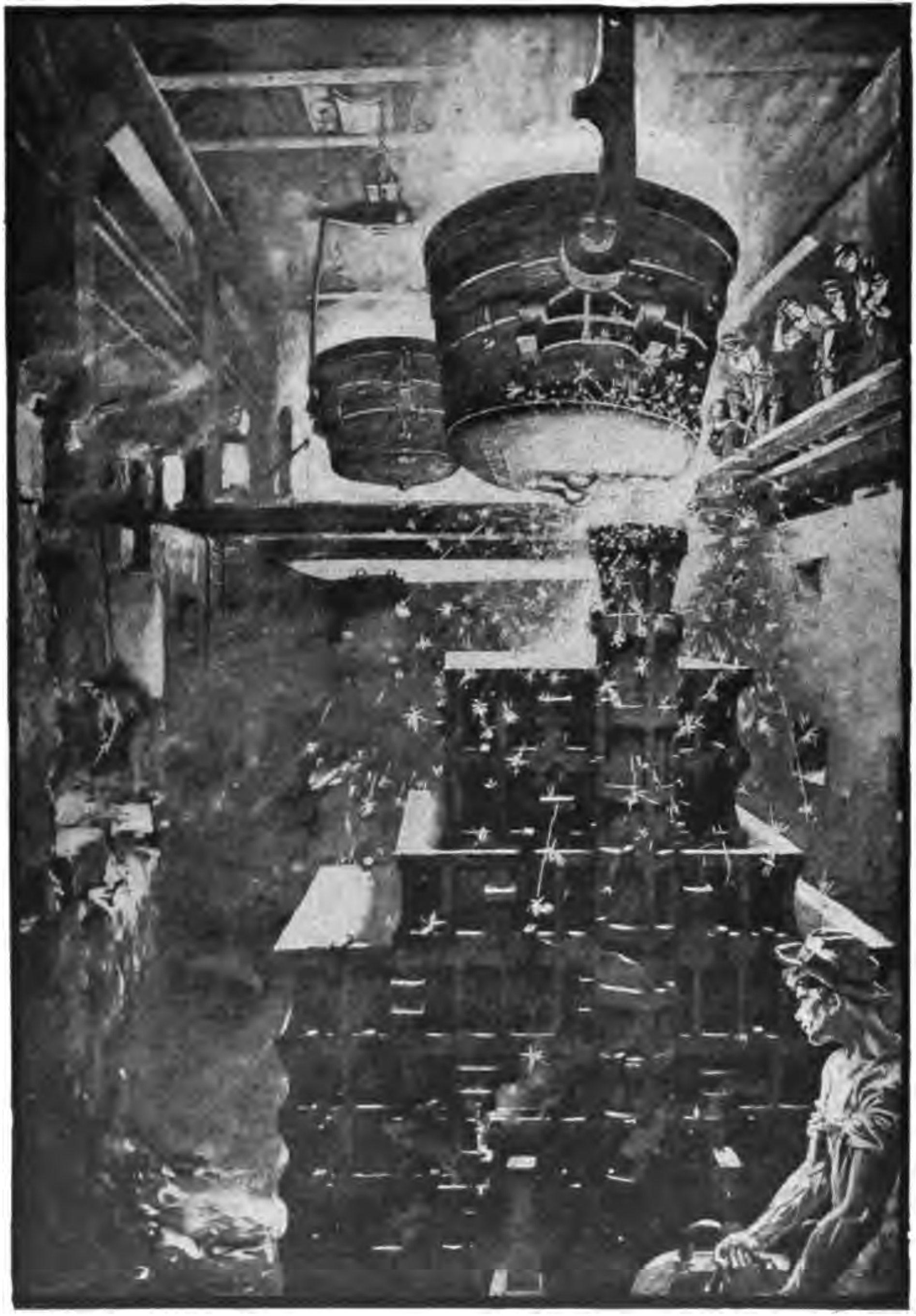
Chemically pure iron is of no value to the foundryman, and it is of most use when mixed in certain quantities with metalloids such as manganese, carbon, silicon, sulphur and phosphorus. Carbon should exist in iron mixes to about 3 per cent. Sulphur should be present in very small quantities, and when there is too much in the mix, lime is mixed with the iron and coke in the cupola. The limestone takes up the superfluous sulphur, and renders the iron more fit for molding.

MAKING PIG IRON DIRECT FROM THE IRON ORE.

In making pig iron direct from the iron ore, much the same principle is used as just described. In that work, however, the ore, limestone and coke are placed in the cupola instead of the iron refined. When the supply of molten metal in that case is sufficient for a flow, the plug is knocked out of the tap-hole, and the molten metal runs out into a sand floor into "pigs." The sand floor has been prepared in long troughs, not unlike plowed furrows, and when the hot metal has been run into them the sand is thrown over the top to help congeal it. In order to make the pigs in a form that can be handled readily, workmen walk about over the top of this hot bed of metal, their feet protected from the heat by great wooden shoes, or blocks of wood tied to the shoes, and with long handled hammers, strike the bars of cooling metal, breaking them up into convenient form for shipment.

STEEL ROLLING.

Sometimes the pig-iron mill is adjacent to the steel rolling mills, and in that event it is desirable to roll the metal while it is yet hot and thus save reheating. This is done by taking the liquid metal in little brick or clay line-carts or ladles to the great steel mixing blasts. These are like immense cupolas without any cover. The iron is poured into these great upright cylinders, with a quantity of "spiegel·iron." This is a combination of metalloids mentioned before, being principally carbon, to give a certain quality of brittleness. The more carbon is mixed with iron, the more brittle it is. When the mix is proper and the combination has been blasted by a fierce blaze, it is run off into great ingots. When these ingots have been cooled a little, but are yet very hot and red, they are carried about through the different processes of manufacture. If it is steel rails that are to be made, the ingots are thrown into great series of heavy rollers, which reduce the width and thickness of the billets but lengthen them out and shape them properly. By the time the steel is cool, they are straightened and complete for doing their part in great railways for the transportation of the world's products.



MAKING A STEEL CASTING.

The molten metal is discharged through an orifice in the great kettle, swung over the molds, and flows in a fiery stream to the place prepared for it.

COURSE OF DEVELOPMENT.

Every steel mill that is built surpasses in some respect all that preceded it. The most modern blast furnace looks like the standpipe of a water system. What is seen is the outer, iron shell of a monster melting pot lined with fire brick. They are arranged in pairs and between the two are other tall cylindrical structures which are literally the stoves wherein is heated the air which is forced into the blast furnace, whence it derives its name. These furnaces must be fed every quarter of an hour or so, and one of the larger size will reduce in one day three or four trainloads of fuel and ore. To feed it, small cars travel up and down an incline, and automatically dump their contents into the furnace. The furnace gases are now saved and utilized in various ways. The slag in some of the larger furnaces is now used to manufacture high-grade Portland cement.

A SIDE DUMP CAR.

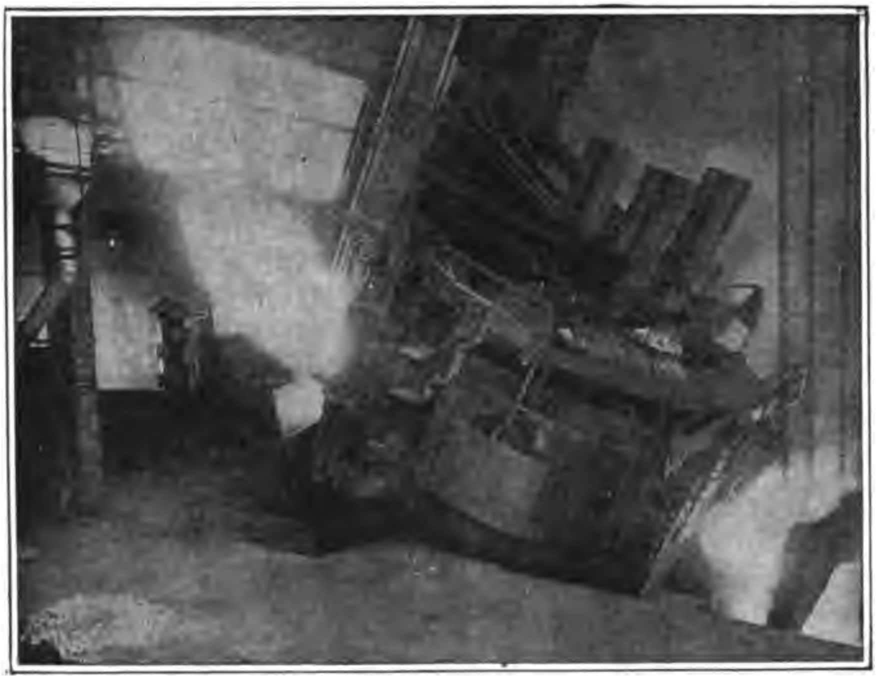
Since steel is the more valuable form of raw material, the most of the molten metal is not cast in the form of pigs, but starts directly from the furnace for the steel mill. The first stage of this journey, while still a molten mass, is on a train of ladle cars. Each ladle is a bulky, brick-lined iron tub capable of holding from fifteen to twenty tons. Four or five of them constitute a train. These cars are hauled by a little locomotive on a narraw-gauge road a distance of a mile or more from the furnace to the Bessemer or open-hearth steel mill. Arriving at the terminal, each ladle is lifted by a giant crane capable of handling twenty-five to thirty tons with ease, and poured into the mixer, which is a gigantic kettle which will hold several ladlefuls of molten iron. Its mission is to thoroughly mix the mass into one uniform total; at intervals an immense ladle holding about twenty tons is filled with this mixture and—if in a Bessemer furnace—is next poured into the converter, all work being done by machinery.

CHANGED TO STEEL.

Here it is changed to steel by having some of the impurities burned out by air blasts and perhaps some ore like ferrum manganese, nickel, or cobalt added. The open-hearth is different in process, but the result is the same. The liquid steel is next poured into iron molds of uniform size, where it hardens in the form of blocks of steel, known as ingots. These molds stand in a row on a train of pigmy cars and each is filled by stopping momentarily under the big ladle of steel; the train finally carries them away; after cooling for a bit, a heavy iron hand known as a stripper drags off the molds, leaving the red-hot ingots. These ingots are now rolled, and pressed out until they emerge as railroad rails, or sheets, or any of the forms of manufactured steel. In all this process the mechanical devices are marvels of perfection and strength. Traveling cranes can handle fifty tons with ease; hydraulic presses that exert a pressure of 14,000 tons; 125-ton knives that cut off great slices of steel as easily as an ordinary knife cuts cheese; huge rolls arranged like a giant clothes wringer, but exerting a pressure of 7,000 tons. These mechanical workers are in evidence everywhere. They rise from the floor, reach out from the walls, and hang down from the roofs. Some are stationary, others are traveling about.

ELECTRIC FURNACE STEEL.

An extremely interesting and very important development of steel production in recent years is the increasing use of the electric furnace, which has been described in another part of this volume. The United States Steel Corporation spent upwards of $1,000,000 in investigations and experiments in this line. As a result there are now electric furnaces capable of treating at one time fifteen tons of steel, and about 10,000 tons of electrically refined steel rails are now in use on various railroad lines and are giving excellent satisfaction. The charge is taken directly from Bessemer converters. The advantages claimed are numerous, but of such a technical nature that it is useless to enumerate them. We will mention, however, one. Steel produced in the ordinary way has a tendency to segregate, that is, in certain centers in the ingot or rail the essential constituents of steel tend to concentrate, from which radiate lines of low resistance and broken rails, with consequent wreck result. This tendency does not appear in steel produced by the electric furnace. Ingots up to eight tons in weight are produced practically free from segregation. The steel is almost perfect in structure and when magnified up to one thousand diameters, it shows no oxide or slag inclosures.



AN ELECTRIC FURNACE FOR MAKING STEEL.

AMOUNT OF IRON PRODUCED.

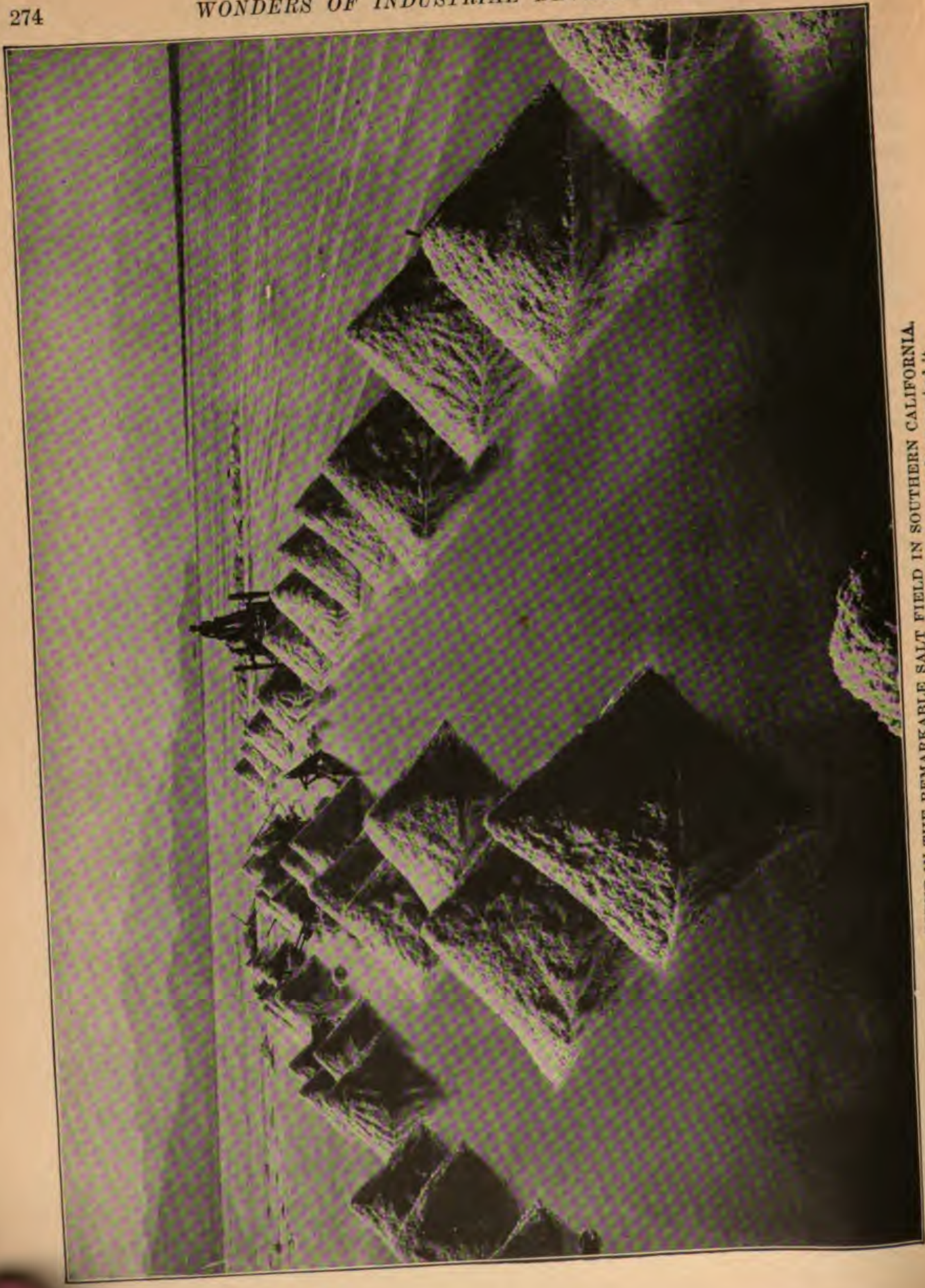
Whether cast in the form of pigs or not, for statistical purposes, the amount of iron produced is estimated in terms of tons of pig iron. The following figures show the enormous growth of this industry since 1900 in the United States. They speak in no uncertain terms of the commanding position our country now holds in the industrial world. In 1900 we produced 13,789,242 tons of pig iron. The next five years was a period of great expansion; in 1905 we produced 25,307,191 tons. In 1918 this amount had increased to 38,700,000 tons, which is about forty per cent of the total amount produced in the world. These figures are meaningless, but we can express it in another way by saying that such a quantity of iron loaded on ordinary freight cars would make a train 14,000 miles long, or more than five times the air line distance from New York to San Francisco. At ordinary speed, it would take a month for that train to pass a given point. Vast as are these figures, we need not doubt that they will be exceeded in future years. As in the United States, so in the world at large, the production of iron has rapidly increased of recent years, it will continue to increase in years to come, since there are nations, and people, and continents that are just waking to modern life. The United States will assist in supplying the great demand coming, and its own home market will also grow to vastly larger proportions as our country develops. It is always unsafe to prophesy, but an estimate of iron production in the United States of 50,000,000 tons for the year 1950 is certainly very conservative.

SALT MINING

Much of the European salt is a product of the most interesting form of mining known. In the salt mines of the Carpathian Mountains the workers live in underground villages, in the great high-ceilinged vaults of the mine, surrounded by walls that glisten with light refracted from myriads of crystals from the walls. The rock salt is found in beds of varied hues, red, yellow, blue and grayish white. It is so firm and dense that large shafts can be driven into it, and large chambers excavated without the use of props and supports. In these mines children are born, and there they have lived for years—in some instances until they were fourteen years old—before they ever saw the surface of the earth.

PRODUCTION IN THE UNITED STATES.

In 1918 the production of salt in the United States was very nearly 50,000,000 barrels of two hundred and eighty pounds each. This was an increase of more than 500 per cent over the amount produced in 1880, showing that the salt industry was no exception to industry in general in its rapid growth in recent years. According to the census of 1910, Michigan produced the largest amount of salt, New York second, Ohio third. Salt as manufactured is graded as fine salt, for table use; dairy salt; packers' salt, for packing-houses, and rock salt. Rock salt includes all mined salt that is ready for shipment, with almost no preparation. Thus it includes salt that exists in solid layers on the surface in some sections.



SCENE IN THE REMARKABLE SALT FIELD IN SOUTHERN CALIFORNIA.
Salt cones ready for the mill after the Indian laborers have washed it.

HOW SALT IS PRODUCED

While salt is mined in many foreign countries, much of the supply of the United States comes from the wells of Kansas and New York, from Salt Lake, in Utah, and from Michigan, Louisiana, Ohio, West Virginia, Nevada and California. Salt blocks are often erected in the vicinity of forests where there are sawmills, so that the refuse from the mills may be used as fuel.

THE MANISTEE (MICHIGAN) SALT WELL.

One of the best equipped plants for salt manufacture is located near Manistee, Michigan. Under the great forest near Manistee is a stratum of salt nearly 30 feet thick, lying about 2,000 feet from the surface of the earth.

PUMPING 2,400 BARRELS OF BRINE IN 24 HOURS.

After a derrick has been built about 80 feet high, the process of manufacturing salt in this vicinity is somewhat as follows. A well is driven by means of pipes and a sand pump, until by the pressure of air pumps brine can be forced to the surface. This brine is pumped at the rate of about 2,400 barrels in 24 hours. As the brine is brought up it is stored in great cisterns. From these cisterns the brine is drawn to settlers, where it is subjected to a heat of 170 degrees F. Then it is allowed to cool and let the impurities settle. Gypsum is the principal impurity, and if it were not drawn off it would form a coating on the machinery of the plant and would clog it.

THE "GRAINER."

The brine now is taken into a long box over what is called a "grainer." This device consists of a long, shallow tank in the bottom of which are several steam pipes. When the brine has been admitted to this the steam is turned on, the brine is heated and evaporation rapidly takes place. To assist in this operation paddles are at work stirring the brine. As rapidly as the brine cools, the salt forms at the bottom of the grainer, and in 24 hours a layer will be found nearly eight inches deep. From this point the salt is lifted by perforated shovels to a runway, and as soon as it is drained, it is shoveled into cars and taken to the storage bins.

One of the plants near Manistee has five

By courtesy of the "Little Chronicle."
PLOWING SALT, WITH THE TEMPERATURE AT 140°.

wells, three cisterns, each 100 feet long, 8 feet deep and 18 feet wide, and six settlers capable of holding 24,000 barrels of brine. These cisterns and settlers when filled hold enough brine to make 10,000 barrels of salt.

THE VACUUM METHOD.

Another process for salt making is called the "vacuum-pan" method and consists in heating the brine in a large air-tight cylinder, where it is boiled by steam. The air pressure is removed to some extent in this boiler and at 150 degrees F. the evaporation is very rapid. The grains of salt fall to the bottom of the cylinder, or "pan," and by means of an endless-bucket belt the salt is taken automatically to bins for draining. After it has drained about 18 hours, it is stored away. Some plants have two pans working, one for day and one for night, for it is necessary to clean the pans every 12 hours. The capacity of each pan is 600 or 700 barrels of salt daily.

COMPRESSED AIR DRILLS BREAKING PACKED SALT.

Salt plants generally have a great supply of salt on hand. It is stored in great sheds several hundred feet long, and frequently become so hardly packed that it is difficult for the laborers to break it up. Coarse salt does not pack so tightly as the vacuum salt. The latter kind often gets as hard as a wall of marble. Then men must work at it with pickaxes, shovels and even compressed air drills. These drills are about ten inches in diameter and are mounted on trucks, so that they may be wheeled about easily. To bring down a quantity of packed salt, a row of holes is drilled about six feet into the wall, a few inches above the floor. Enough will then fall in to keep a gang of men packing for a number of days.

By courtesy of the Southern Pacific Railroad Company.

DRAWING SALT IN CALIFORNIA.

PETROLEUM INDUSTRY.

It is not a great stretch of imagination to speak of drilling for oil and gas as mining operations. It is extracting from the earth wealth, which nature has stored in subterranean reservoirs comparable with that of iron ore and coal deposits. The shaft, indeed, is very small, and we frequently go to great depths, but it is truly a form of mining.

The petroleum industry is barely fifty years old. It has grown with giant strides, and is now one of the great industries of this country, and the production is increasing rapidly. In a general way, all know about the discovery of oil in Pennsylvania, and then the finding of it in sections farther and farther away, until finally we learned that it existed widely distributed, not only in the United States, but over the surface of the earth generally. Nature has not disclosed the alchemy of her process; we only know the strata containing oil must be porous in construction, underlying and overlying which are impervious strata. Thus confined, it obeys all the laws of liquid pressure. The gushers and the flowing wells of oil are on exactly the same principles as artesian wells of water.

SCENE IN THE CALIFORNIA OIL FIELDS.

AMOUNT PRODUCED.

It exists in far greater quantities than we formerly imagined; it is not confined to any one geological age or formation. Along the Appalachian Mountains it is found in various sandstone formations; in Indiana and parts of Ohio it is also found in limestone strata; farther west and south, in still other formations. In spite of the fact that fields first developed have become exhausted, production as a whole in the United States has increased at a remarkable rate. In fact, the increase is in keeping with our great increase in the production of iron and coal and general industry. The following statistics show the rapid increase in production since 1900:

1900—	2,673,069,218 gallons
1910—	8,801,404,416 gallons
1912—	9,328,755,156 gallons
1914—	10,434,741,660 gallons
1918—	14,355,600,000 gallons

Here again figures are utterly meaningless. We gain a faint idea of their immensity when we discover that the last amount would fill a pit five feet deep, five miles long and two miles wide, which would be a veritable lake of oil. We gain a clearer idea of the importance of the industry when we learn that the value of the crude petroleum produced in the United States in 1918 was nearly fifteen times the value of all the gold mined in same area the same year.

THE WORLD'S PRODUCTION.

The amount produced in the world has also increased with great rapidity, but in 1918 the United States produced considerably more than one-half of the total production of the world. For years the center of oil production in the United States was in Pennsylvania, then it commenced to swing west. But after reaching California it returned to Oklahoma. In 1918 Oklahoma-Kansas field produced almost one-third of the total amount, California comes next, the Appalachian field next, and then the Gulf Coast.

What the future production will be is impossible to determine. The probabilities are that it will continue to increase, and very rapidly so, for years to come. In 1908 the United States Geological Survey estimated that there were 8,850 square miles of oil-producing territory in the United States. But that is only known areas. There may be deposits as rich as any we have heretofore discovered waiting some fortunate explorer. Undoubtedly, the world's production will greatly increase. In 1918 there were 500,651,086 barrels of 42 gallons each. We would have to increase the depth of the pit we dug for the American oil to eight feet to hold that amount. We know in a general way that there are vast deposits of petroleum in Asia and in South America, probably in other sections, not yet drawn upon.

OPENING OF NEW TERRITORY.

The poet has described the dramatically sudden changes of fortune in the life of the pearl diver. One moment, a pauper, he prepares to dive; the next moment, with his pearl, he rises a prince. Changes of fortune fully as startling and as dramatically sudden occur from day to day in all sections. When the boom is on in any newly developed oil section, land suddenly doubles and trebbles in value, speculation runs riot and men poor one day are rich the next. The exciting scenes of fifty years ago in Pennsylvania have been reenacted, with local variations only, in Ohio, in Indiana, in Texas, in Oklahoma and California. One instance of poetic justice is observed in the case of some of our Indian tribes, who, despoiled of their land in other sections, driven from pillar to post, finally located in Indian Territory, by reason of the oil underlying their lands, have become rich, with the greatest per capita wealth in the world.

DRILLING FOR OIL.

The actual drilling for oil is a very interesting work. Derricks from 64 to 80 feet high, usually built of wood, are generally used, although in fields where the depth is not great, drilling machines carrying their own derrick are often used.

The drilling mechanism consists of a steel bit, a few feet in length, varying in diameter from a few inches to a foot and a half, depending on the depth of the well and the formation through which it is sent. The bit is attached to a steel stem from four to six inches in diameter, from 50 to 60 feet in length. Together these constitute the drill which pounds its way through the various strata which overlie the oil containing one. These formations vary from hard, flinty strata to caving mud or sand formations. One of this nature necessitates the use of a metal casing slightly smaller than the hole already drilled, which casing must be continued to the next hard stratum, and this, in turn, necessitates the use of a smaller drill as the drilling continues. Consequently, in some localities, in drilling deep wells the diameter of the hole is several times reduced from what it was at starting, and several lengths of casing are required.

Water is used freely, and by examining the mixture bailed out the nature of the formation through which the drill is passing can be easily determined. When the "strike" is made, the oil often bursts forth with great velocity, sometimes flowing 100 feet into the air, while at other times it makes very little showing until the sand is broken up by a shot of nitroglycerine. After the "strike" is made and the well is properly cleaned out, the oil is run into storage tanks, where it is cared for until shipped.

HANDLING OIL.

Every great industry has developed only as transportation facilities have been so perfected that its product can be moved economically. The petroleum industry had to invent a system of transportation peculiarly its own. It takes the form of underground pipe lines, through which the oil flows in places by gravity, in others forced along by powerful pumps. Few realize there are thousands of miles of main pipe lines in the United States, that they stretch across entire states, bringing the oil from distant fields, perhaps hundreds of miles away, to central refineries. This invention revolutionized the oil industry and in addition to transporting oil, poured a steady stream of gold into the rapacious coffers of the Standard Oil Company. They have become so important that by a series of recent decisions the Supreme Court is making them common carriers and thus seeks to bring them within the purview of the Interstate Commerce Law.

USES OF PETROLEUM.

The use of petroleum as an illuminant is worldwide. It has been said that civilization follows the introduction of coal oil for lighting purposes. If so, the Standard Oil Company is the greatest advance agent of civilization ever known, for it sends its products literally to the four corners of the earth. But new uses are constantly being found for petroleum and its derivatives, one of which is gasoline, and we know what an important part that liquid plays in the automobile industry. It alone has made possible the flying machines and submarines, which are playing such an important part in modern warfare. Petroleum is being used more and more as fuel. Oil-burning engines are being introduced in railroads, steamships, and in manufacturing plants. However, prominent engineers do not think there will be a wholesale exchange of coal for oil for steam purposes. There is one exception to the foregoing. Its use on battleships will probably increase and ultimately drive out other forms of fuel. In this case, economy is not the question. The navies of the world will demand the best fuel possible, regardless of cost. It is thought that far-seeing nations have been providing for future supplies. It has been hinted that England has a grip on the oil-producing sections around the Persian Gulf. It has been openly advocated that the United States take possession of the immense oil reserves in California, so as to conserve them for future needs.

NATURAL GAS

Intimately associated with petroleum is natural gas, though it is often abundantly found in sections remote from petroleum area. For a long time this product, often encountered in drilling for oil, was allowed to go to waste, and it was not until 1872, near Titusville, Pennsylvania, that a beginning was made in using natural gas for fuel and light, in the modern way, on an extensive scale. Its use in a small way, and in isolated cases, had been known for fifty years, the town of Fredonia in New York being lighted by natural gas in 1821. A gas well is one where the drill has tapped one of nature's gasometers in which has been stored great quantities of gas, manufactured in some unknown way, in some remote past. It is requisite that the reservoir be composed of some porous formation, like the sands of the Appalachian area, or the limestone formation of Indiana and Ohio, and the gas there gathered must be confined by overlying rock strata through which it cannot pass. The pressure of the confined gas is theoretically about the same as the pressure of a column of water the depth of the well; practically in most fields, it varies from 375 to 750 pounds per square inch; a pressure as high as 1,500 pounds has been experienced.

PRODUCTION OF WELLS.

Wells flowing 1,000,000 cubic feet daily are valuable wells. In the Ohio and Indiana fields, when first developed, many wells flowed from five to seventeen million cubic feet daily. The Big Moses well on Indian Creek in West Virginia flowed at the rate of 35,000,000 cubic feet daily. But gas is soon exhausted in all sections, though the total amount of gas produced in the United States has steadily increased. The figures given

GAS WELL AT KANE, PA.

The pressure was 1,500 pounds per square inch. Said to be the only gas well where the volume of escaping gas could be photographed.

are the values of the gas produced for the given years. In 1882, when the statistics begin, the value was $215,000. Thence it rapidly increased as follows:

1890	$18,792,725
1900	23,698,674
1910	70,750,158
1912	84,563,957
1918	120,000,000

FUTURE PRODUCTION.

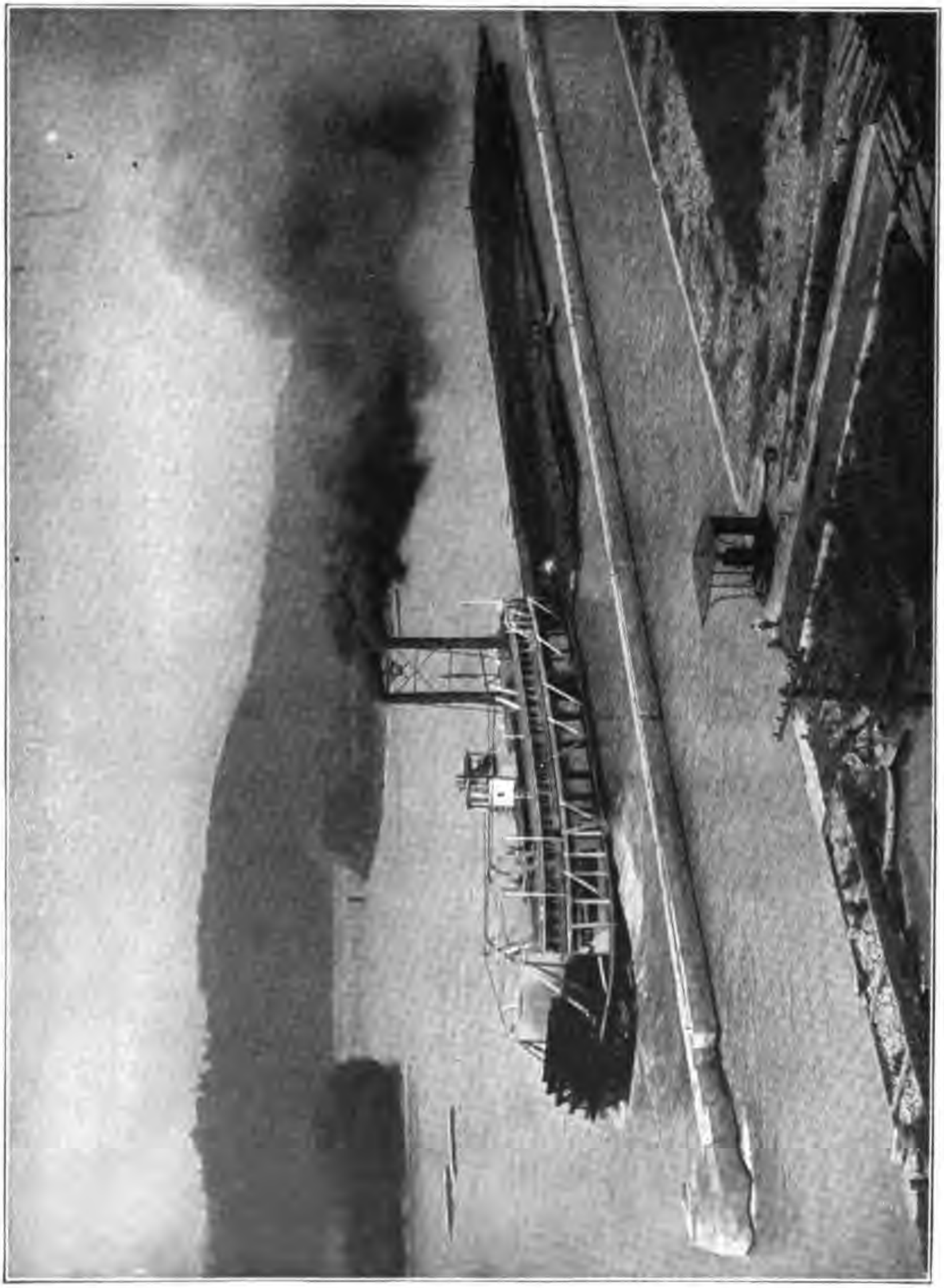
Its future production is very problematical. It would seem as if the supply would soon be exhaused, but in this respect, also, nature may have a surprise in store. In 1908 the United States Geological Survey estimated that there were in this country 10,055 square miles of gas-producing territory. The world's supply will, doubtless, increase for years to come, since there are vast supplies known to exist in parts of Asia, especially around the Caspian Sea and Persian Gulf. Natural gas is used for both illumination and fuel purposes and is piped a long distance, Cincinnati, Ohio, being supplied with a large amount of natural gas from West Virginia fields.

TOTAL VALUE OF NATURAL PRODUCTS DERIVED FROM THE CRUST OF THE EARTH IN 1918.

We have now given an outline of the principal products of mining operation. We can not go into details as to other important branches of this industry. The following summary of wealth extracted from the crust of the earth in the United States during the year 1918 should be of absorbing interest to all Americans, and we must remember that the figures for virtually all of these articles will, doubtless, increase, and rapidly so, for years to come. The statistics point in no uncertain terms to the compelling influence the United States will exert in the civilization of the future.

Metallic Productions.	
This term includes the value of pig iron, of which we have made special mention, and such productions as gold, silver, copper, etc.	$1,621,832,177
Non-Metallic Products.	
This term includes coal, oil and gas, which we have considered, and such products as sand, lime, valuable earths, etc.	$1,878,567,232
Not Specified.	
Which includes such substances as alum clays and some other chemicals	$ 1,500,000
A grand total of	$3,501,839,409

A value more than forty times the value of all the gold produced in the United States the same year.



SCENE ON A BUSY RIVER.

AGRICULTURE

The agricultural industry far exceeds in importance any other industry in the United States. The basis of our wealth is not found in the products of our mines and manufactures, vast though they be, but in our fields of grain and cotton; our meadows and cornfields, our orchards, vineyards and forests, our flocks and herds. Within our borders are grown all varieties of agricultural products. Such quantities of cereals are produced that the figures expressing them can not be comprehended; cotton in such profusion that a freight train as long as from New York to Chicago could barely transport it. We grow all manner of plants producing sugar and add to the amount by the yield from sugar beets and maple trees; in our meadows are all varieties of forage plants; in our fields and gardens, all manner of vegetables.

INTERESTS INVOLVED IN AGRICULTURE.

In order to gain a general idea of the agricultural industry, the following statements may be considered. According to the last census there were 6,361,502 farms, the total area of which was 878,798,325 acres, 478,451,750 acres being improved. The average size of the farms was a little over 138 acres. The number of persons engaged in agriculture, forestry, and animal husbandry was 10,851,702. The total value of the farm lands, buildings, improvements and farm animals in 1918 was the inconceivable amount of $40,991,449,090, which represents the capital invested in agriculture. The value of the farm animals alone that year was $8,263,524,000. In number, these animals were:

Cattle	67,370,000
Horses	21,563,000
Mules	4,824,000
Sheep	48,900,000
Swine	71,374,000

Some of the principal crops produced in 1918 were:

Corn, bushels	2,582,814,000
Wheat, bushels	917,100,000
Oats, bushels	1,538,359,000
Potatoes, bushels	40,010,600
Cotton, bales	11,700,000
Tobacco, pounds	1,340,019,000
Wool, pounds (1917)	245,573,000
Hay, short tons	89,824,000

With these amounts in mind, it is not surprising to learn that the total value of agricultural products in 1918 was $19,443,819,000. It may help to a slight comprehension of these figures to state that if twenty-dollar gold pieces to that value were piled on top of each other, flat sides down, they would form a column 890 miles high, just about the air line distance from Chicago to New York.

WHAT OF THE FUTURE.

In view of these enormous crops and the further fact that the fertile public land is about gone, it becomes an interesting question whether the United States has not reached the limit of production, and if so, owing to our rapidly increasing population, what of the future? At present we are a nation of approximately 110,000,000 people. Probably before this century shall have passed, these figures will be doubled. Wiil not our food supply become deficient? Our railroad mileage may expand, our coal and been attained where it was supposed nothing could be grown. We can go into other lands and procure plants which nature has evolved for dry sections, like the Tipary bean introduced into Arizona, which seems to defy drouth, or if it really gets too severe, it does not die, but simply suspends operations until moisture comes, when it goes right ahead. Nature has evolved immense quantities of apparently useless cactus in the arid Southwest. We have been shown how to breed the thorns off, and the result is a nutritious product. New varieties of fruit are produced almost at will. New varieties of potatoes more than double what was considered the generous yield of former years.

IRRIGATION.

In the meantime, we are learning how to cope with scarcity of moisture by scientific irrigation. A further development of the reclamation work of the government will render many million acres of land, at present almost a desert, the most fruitful we have. In 1918 the United States government had under construction thirty-three irrigation projects, on which it has already spent very large sums, which when completed will irrigate 3,142,745 acres. In prosecution of this work, the highest engineering talent has been brought into action. Mountains have been tunneled, rivers led into new channels, immense reservoirs formed, masonry dams constructed so high that a twenty-story skyscraper could be looked down upon from their crest, and hundreds of miles of drainage canals completed. But all that has been done, or is being done in this matter, is only a beginning. Immense areas can be thus improved, and doubtless will be improved in the near future. Although the expense of installation is great, the improved value of the land more than returns it. While the area of land which can be reclaimed by irrigation is relatively small, still if only 5 per cent of it can be ultimately reclaimed, owing to the dense population that can find location there, and the intensified system of farming that is the vogue in all irrigated sections, the population in the western half of the United States will be almost as great as that now located in the eastern half.

SCIENTIFIC FORESTRY.

In the meantime, scientific forestry is increasing the number of trees and bringing large areas under tree culture, which before were only featureless plains, and it is generally thought that the more abundant the growth of trees, the more readily is moisture preserved for agricultural purposes, while the intensity and extent of floods is diminished. The mere extent of agricultural operations, cultivating the soil, is itself exerting a favorable influence on climate. Experience in Oklahoma, Dakota and other sections amply confirm this conclusion.

CONCLUSIONS.

All of these methods combined—the conservation of what little moisture there is, scientific irrigation, forestry and cultivation—under the stern pressure of necessity, the necessity of providing more food supplies, will clothe very much of our arid sections—the American Desert of early geography—with a luxurious mantle of green, with waving fields and grazing herds. Looking into the future, then, we see the average crops of the present doubled, perhaps trebled, from the same acreage as at present; understanding the true principles of soil nourishment, the fertility, even under increased production, will increase instead of diminish, consequently when present population doubles or even trebles, food supplies will be abundant.

THE DEPARTMENT OF AGRICULTURE.

The capable work of this department has accomplished great results in the agricultural awakening of this country. In its earlier stage its principal business was to provide seeds for aspiring statesmen to bestow on their constituents. But that period has long since passed. It has now become one of the great departments of government, and its head is a member of the president's official family. As being the department which is charged with looking after the agricultural interests of our country, its activity is world-wide, and far more varied than the great majority even dream. In scientific research, extraordinarily valuable results have been achieved.

Its agents are in every land, seeking for whatever will improve our agricultural interests. They are in Persia hunting new varieties of peaches, since Persia was the original home of the peach; they are in China and Ceylon for tea plants to be cultivated in the Carolinas; they are in Mongolia and Siberia for hardy forage plants for our northern plains; they are in Japan for new varieties of rice; in North Africa for dates. They are even in search of useful parasites and insects. The orange interest in California was practically saved from destruction by introducing a foreign parasite that enjoys feeding on the scale insects that were destroying the trees. But recently the great alfalfa fields of the West were threatened with serious injury, if not destruction, by the alfalfa weevil. The department sent agents to Italy to get a supply of very minute parasite, with a very long name, and an extraordinary appetite for the weevil. These desirable emigrants were made at home in the alfalfa section, and the weevil ceased its activities.

The bureau of animal industry has been of incalculable benefit to the meat industry. It was agents of this department that discovered how Texas fever is spread by means of ticks. Having found the cause of the fever, they began an open war on the ticks and thus saved the cattle. They discovered the bacillus of hog cholera and prepared an inoculation for it that mitigates the evil; they introduced the use of tuberculin for determining the presence or otherwise of tuberculosis in cattle. Its inspectors are busy in all slaughtering house centers, inspecting the cattle, hogs, etc., there slaughtered. The chemical division analyzes soil and has suggestions to make as to fertilizers needed.

AGRICULTURAL EDUCATION.

Both the general government and the various states, recognizing the vital importance of agriculture, have made provisions for agricultural schools and colleges. More than fifty years ago Congress appropriated 10,000,000 acres of land to establish in each state at least one agricultural college. Such colleges now exist in every state and territory in the Union, and the general government has still further provided for them. In 1918 there were 69 colleges in the United States that were either exclusively agricultural colleges or at least had provided for a full course of instruction in agriculture, and thousaands of students were taking the course. Eight state universities, not purely agricultural colleges, reported 6,000 students taking that course.

By two separate bills the general government further provided for the location of state experimental stations. In 1913 there were 67 such stations endowed by the United States government. Many states have further provided for district and even county experimental stations. In Ohio, there are now in addition to the Central Experimental Station, four district and four county experimental stations. Further, many states are now making provisions for teaching agriculture in the common schools. The experimental station undertakes investigations along almost all lines of practical husbandry, especially problems concerning fertilizing, dairying and feeding.

So from every important angle of observation, we conclude that the agricultural industry in the United States is to be no exception to the probable great increase of industry in other departments. Its growth will keep pace with development in other directions and the census figures of decades hence will reveal the story of development in all material features, unparalleled in the history of the world.

THE BEEF INDUSTRY

The beef industry is a very important subdivision of general agricultural industry. Its being of such extent and importance, resulting in concentration in a few great shipping centers, controlled by a few large corporations, making possible improved methods and specialization of details call for separate mention.

The great centers of beef industry are in the West. The eastern sections of the United States are pre-eminently the center of manufacturing interests, of coal and iron productions; there we have experienced our great railway developments, population has increased rapidly and much more intensified agricultural methods prevail. The vast plains and prairies of the West have become the principal source of the nation's food supply. This is especially true of meat products. The center of this production has steadily moved westward. Raising cattle and sheep demands a large area of grazing land, which the manufacturing East cannot supply. And thus our great cattle pastures are in the West, two thousand miles from the eastern seaboard. Swine only can be raised on a large scale in the corn producing sections of the West. The result has been a westward swing of the beef industry, shown by the last census, which estimates that nearly 50 per cent of all animals used

THE MODERN STEER.

SWIFT & CO.'S OFFICE, CHICAGO—LARGEST PRIVATE OFFICE IN THE WORLD.

for food in the United States, except poultry, is west of the Mississippi River.

The demands of all sections of our country for beef products can only be met by transporting the same from the West, but economy demands that instead of the animals we transport only their valuable parts. In other words, that the animals be slaughtered near where they are raised, and the beef be sent east in refrigerator cars, or otherwise be prepared for consumptioon in the shape of hams, bacon, sausage and cured pork. Naturally the slaughtering industry centralized in a few shipping centers, since to carry it on successfully a vast amount of capital is required, special machinery used, the business systematized in accordance with modern methods, and special transportation facilities provided in the shape of improved stock cars for live stock, refrigerator cars for the prepared product; with enormous stock yards and costly buildings. The result has been the development of a wonderful industry, which has grown with great rapidity; its yearly products, running into the hundreds of millions of dollars in value, are eagerly sought by warring nations, not less than secluded hamlets in our own country.

THE OLD STYLE STEER.

STATISTICS.

The following figures will be found of interest as showing the very great importance of the meat industry in this country. According to the last census there were 1,641 establishments engaged in slaughtering animals and preparing meat foods. One hundred and eight thousand, seven hundred and sixteen persons, including proprietors, were interested in this work, and the amount of capital invested was $383,249,000. They paid out for their raw material (various animals), $1,209,828,000, and the value of their finished product was $1,370,568,000. It will be noticed they are all situated in the West.

SCENE ON A WESTERN CATTLE RANCH.

The location of the principal centers of this industry and the number and kinds of animals there purchased for slaughtering purposes in the year 1918 is as follows :

	Cattle	Hogs	Sheep
Chicago	3,820,271	7,168,852	3,595,228
Kansas City	2,902,253	2,276,995	1,498,350
Omaha	1,719,822	2,796,596	3,016,031
St. Joseph	670,167	1,920,177	678,853
St. Louis	1,404,741	2,705,614	331,034
St. Paul	1,197,129	1,927,952	429,617
Sioux City	706,718	2,149,115	267,441
Cincinnati	1,239,042	1,239,042	270,329
Denver	653,377	351,903	2,049,898
Indianapolis	501,156	2,350,730	102,293
Wichita	354,933	471,837	25,424

THE WORLD'S GREATEST MEAT MART.

The Union Stock Yards are located on the western outskirts of Chicago. It is so important that it gives its name to the entire section. Into these yards enter the many railroads that make Chicago the railroad center of the West. The total area of the yards is a trifle over 600 acres, 300 of which are paved with vitrified brick tiling, which makes the surface most substantial. Running through the pens are 25 miles of streets and alleys, 38 miles of water troughs and 60 miles of feeding troughs. In addition to these there are over a hundred miles of water, sewer and drainage pipes. The total cost of the yards is more than $50,000,000. They were built in 1865, and the first day's receipts of cattle, sheep and hogs numbered a trifle over 300. Now, it is not an uncommon thing to see 20,000 cattle, 30,000 sheep and 45,000 hogs in the yards at one time. We have given the figures of animals received in 1918. The animals, of course, vary from year to year. In the yards there are about 15,000

NEW ARRIVALS AT THE STOCK YARDS.

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pens, of which 8,000 are roofed in for sheep and 3,000 pens, or "double decks," for hogs.

200 MILES OF RAILROAD TRACKS.

Inside the yards are grouped nearly a score of separate packing houses, all doing an enormous business. There is also a big office building known as the "Exchange Building," which accommodates nearly 300 commission firms, the general offices of the stock yards company, a bank, and a branch of the Bureau of Animal Industry, of the United States Department of Agriculture. Surrounding the yards is a network of tracks comprising a total mileage of nearly 200 miles.

If the visitor to Chicago wishes to witness a busy scene, let him or her go to the stock yards between 5 and 9 o'clock any week-day morning, and they will see a great horde of people flocking to their daily work. Inside the yards alone there are employed nearly 50,000 men, women, boys and girls. The early morning is devoted to the unloading of the live stock. After this is accomplished begins the sale. Soon after the sales are made, the stock is weighed to the purchaser, and if it is to be reshipped, is again loaded into cars and forwarded to its proper destination.

GOVERNMENT INSPECTION OF MEATS.

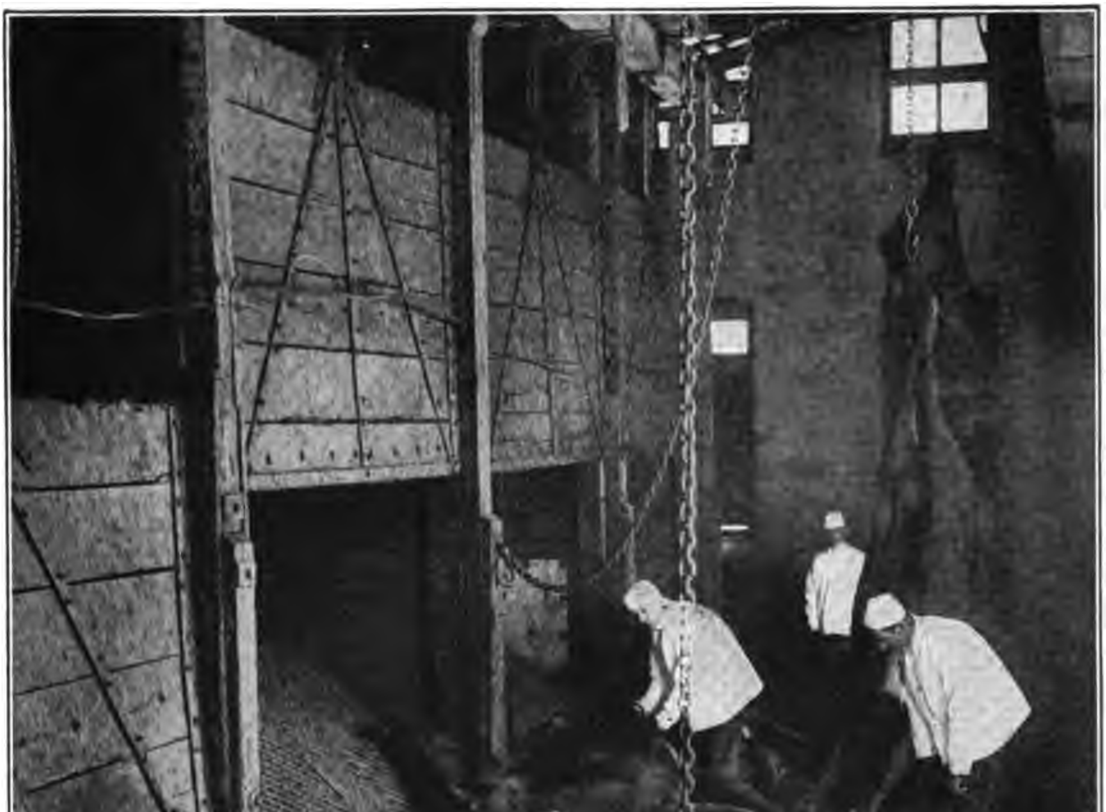
When the cattle, hogs and sheep are in the pens, the government inspectors step in and make a thorough inspection of all live stock received. Condemned animals have a tag fastened in their ears. These animals are slaughtered under the direction of the Bureau of Animal Industry, and, if the meat is found to be diseased, the carcass is condemned and goes into the tank. In addition to this inspection, the Government keeps a man in every packing house in the yards, whose duty it is to inspect all animals slaughtered, and so thorough is the work done that an animal can be traced from the time it arrives at the yards until it reaches the retail butcher's shop.

PORK TESTED BY THE MICROSCOPE.

Pork that is to be exported is subjected to a rigid miscroscopic inspection, and if found to contain disease of any kind, the carcass in which the disease is found is ordered "tanked" at once. All this work is done by a corps of expert microscopists, under the direction of the chief of the Bureau of Animal Industry. Tiny bits of meat are cut from each carcass that is to be exported, and after being placed in a tin box, are labeled, and later, taken to the microscopic department, where an inspector (usually a woman) cuts the meat into jelly with a tiny pair of scissors, after which the pulpy mass is placed between two pieces of clear glass, pressed together, and then subjected to a powerful microscope. If the meat is diseased, the microscopist will immediately discover it, and that carcass will be condemned. In Chicago, there are 90 inspectors at work during the whole year.

PROCESS OF SLAUGHTERING AND DRESSING.

In the great packing houses that abound within the yards, there is a familiar jest, that everything of the animals slaughtered except the squeal of the pigs is saved, and this is to-day literally true, for, that which once was loss is now made into various things. So complete is the utilization of that which was once waste, that the profits



CATTLE KILLING. Courtesy, Armour & Co.

Steers rolling from stalls after being knocked unconscious.

of a big packing house on its by-products amount to a small fortune each year. Let us follow the process of a typical packing house from beginning to end. The buyers of the concern purchase such cattle as are wanted for the day, which are driven from the pens over long runways, to the pens of the packing house, which is located near the slaughter house. Some of the packing houses have fat steers trained to lead the other cattle to the foot of the gangway, there to turn and leave them, while the victims go on to their fate. From the gangway there is an incline which leads into a small stall, or pen, directly opposite the killing floor. Above, on small platforms, the "knockers" run along, and with a small sledge-hammer, strike the cattle upon the head until they fall to the floor, stunned. Then the doors open automatically, and a moment later, the animal is dangling by the hind foot at the end of a long chain, which suspends the carcass high enough for the butcher to cut its throat. The heads are removed at the same time the carcass is drained of blood, and then in quick stages the hoofs, shanks and entrails are removed. The carcass is split down the backbone. It travels along on an endless chain, or trolley, is washed, and later taken into the great coolers to be chilled.

NOTHING WASTED.

Everything that pertains to a slaughtered beef is sold and put to use. The horns become the horn of commerce; the straight lengths of leg bone go to the cutlery makers for knife handles; the entrails become sausage casings and their contents make fertilizing material; the livers, hearts, tongues and tails, and the stomachs that become tripe, all are sold over the butchers' counters of the nation; the knuckle bones are ground up into meal for various uses; the blood is dried and sold as a powder for commercial purposes; the bladders are dried and sold to druggists, tobacconists and others; the fat goes into oleomargarine, and from the hoofs and feet and other parts, come glue and oil and fertilizing ingredients.

Directly above the slaughter houses is a series of rooms full of bones and horns. The bones are boiled to get the fat of the marrow as well as to clean them. Then they are dried and shaken about until they are smooth and clean as cotton spools. The knuckle bones are cut from them, and one room is filled with the ground-up pulver of these parts. The white and pretty bones are shipped to Connecticut, England and Germany, to be worked into knife handles, fan handles, tooth-brush handles, backs for nail brushes, sides for pen knives, and into button-hook handles, shirt studs, cuff buttons, and so on, ad infinitum. What is to become of the horns is still more astonishing. By heating them and then tapping them skillfully, the operators loosen the soft cellular filling which solidifies and strengthens each horn. The substance around this, between it and the inner surface of the horn, goes for glue; the rest is ground up into bone meal. The horns are then sent to makers of horn goods, who, by cutting each horn skillfully and then pressing it between heavy rollers, manage to spread each into a flat ribbon. In this shape, it can be used in a thousand ways. The artificers who do this work cut each horn spirally, so that it becomes a tight curl capable of being straightened out. By immense pressure the curve is taken out of it. Good horns sell for $100 per ton.

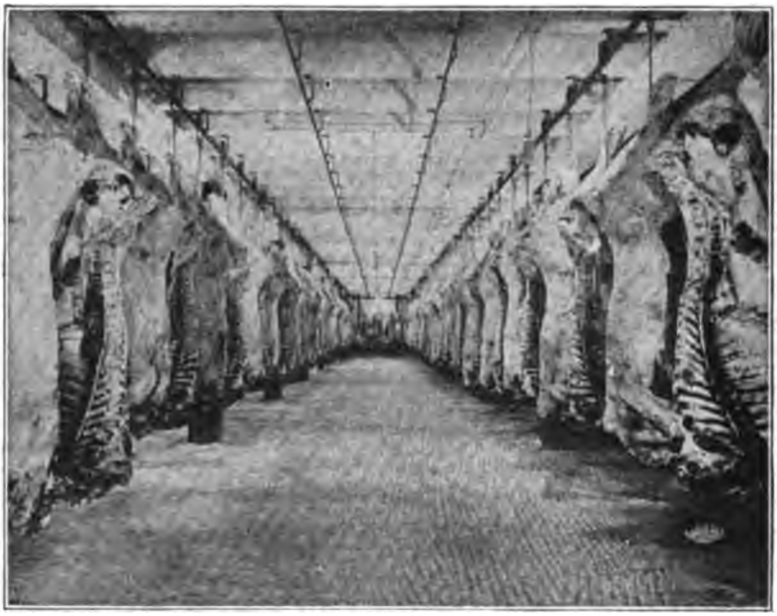
REFRIGERATION.

The refrigerating and cooling rooms are kept at a temperature of 36 degrees, yet, when the meat fresh from the slaughter is railroaded into such a room, the animal heat in it warms the room for a considerable time, and fills it with steam as with a fog. As soon as it is cool, the sides of beef become firm, hard and almost appetizing. Everywhere, except at the actual scene of slaughter, these houses and their work are clean and above criticism.

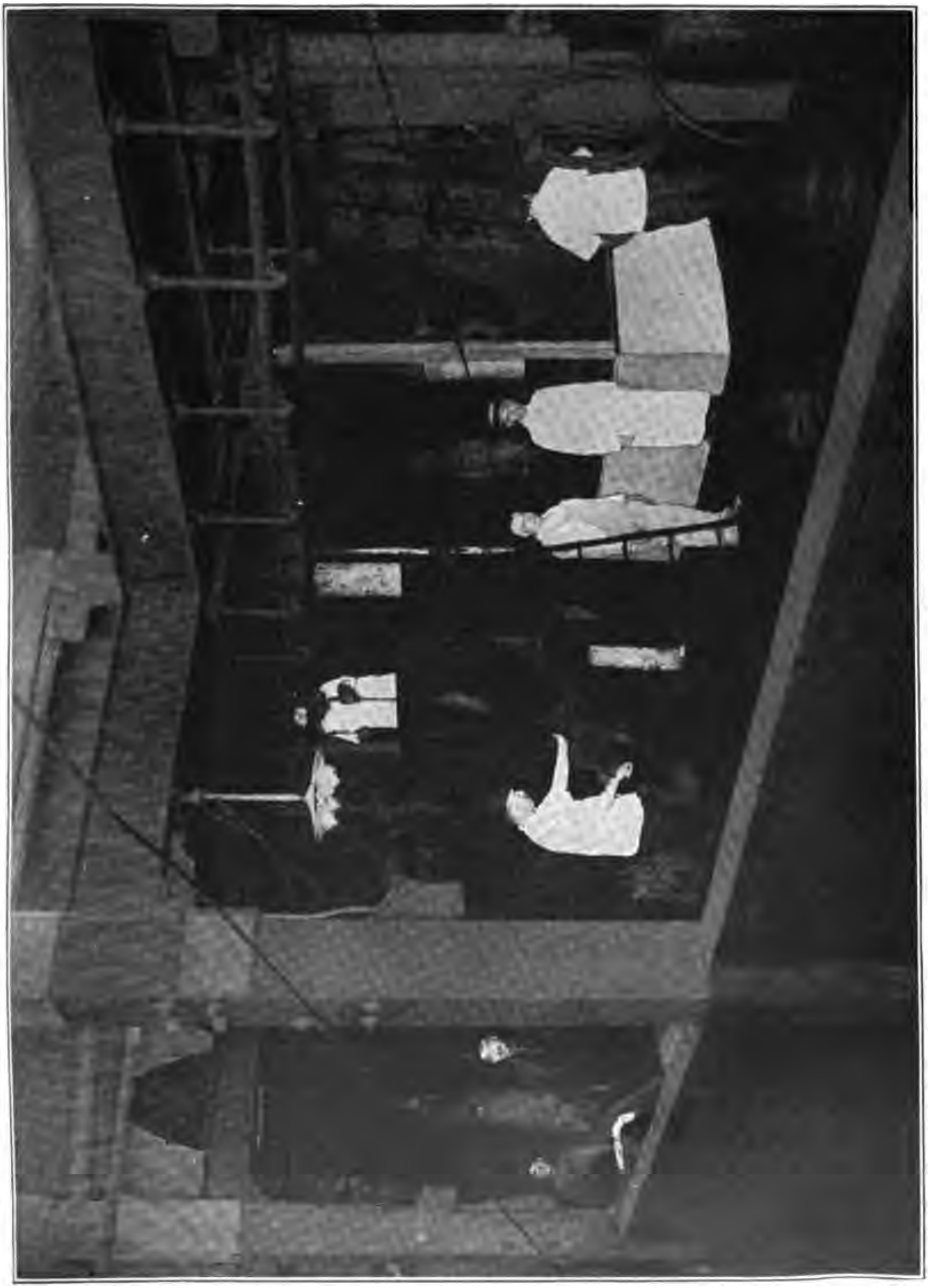
HOG KILLING AND DRESSING.

The killing of hogs is done in a much more peculiar manner than the slaughtering of cattle. The hogs are run into a catching pen, from where they are caught up and forced upon a revolving wheel, where the butcher stabs them to the heart, and death is practically instantaneous. From the wheel the dead body swings along, to be loosened over a vat of scalding water, into which it is plunged. Here the bristles are loosened. Then a great rake scoops out a hog, and it falls upon a runway, where a chain that is hooked to its nose pulls it through a steam scraper. The knives of this machine are set at every angle, and miss no part of the hide on the body.

When out of reach of the scraper a number of men pass the body along, to remove every bristle and speck that was missed. Then the body is washed with a hose, and its head is almost cut off. Next it is disemboweled. Then the lard is removed, the head is cut off, the tongue taken out, and the body is split and passed along to the cooling room. The blood is turned into albumen for photographers' uses, sold to sugar refiners or transformed into fertilizing powder. The bristles go to brush makers, shoemakers and upholsterers. The fat is valuable in many forms, the intes-



SECTION IN COOLER.



Courtesy Armour & Co.

HOG KILLING AT ARMOUR'S PACKING PLANT.

tines become sausage casings, livers, lungs and hearts are made up into sausage meat, and parts of the meat of the heads made up into headcheese. The feet are canned or pickled, or worked up in the lard tanks.

SHEEP KILLING.

The method used for killing sheep is similar to that heretofore described, except that the sheep are suspended two by two on hooks that run along a continuous trolley line. As each pair passes the succession of men in waiting a new step in the process is completed. The killer sticks the knives into their throats at the rate of 25 per minute, and the animals continue to pass through the hands of specialists at that rate of speed, until the carcass appears at the end of the trolley, spread apart with wooden braces, and ready for the refrigerating room.

SHEEP KILLING.

KILLING "KOSHER" CATTLE.

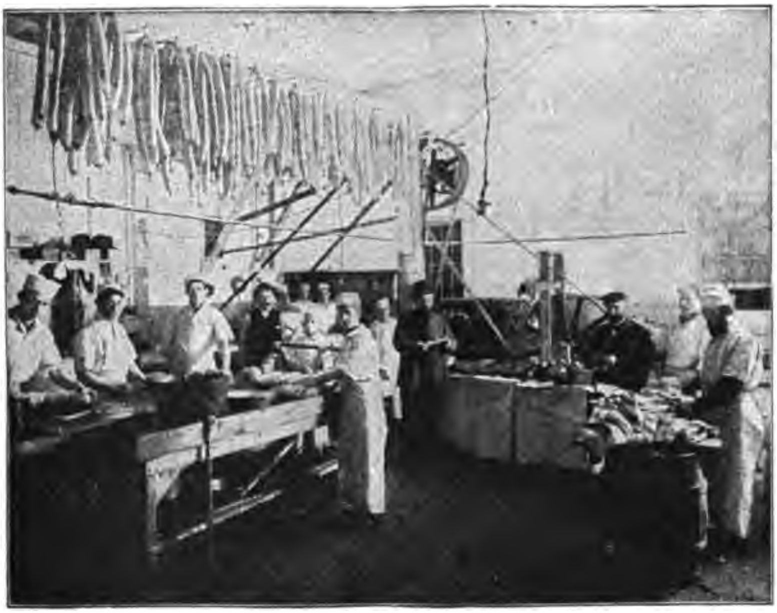
It is proper to mention a peculiar feature of the yards, viz., the killing of cattle intended for the Jewish markets. For this purpose a "Kosherman" is in attendance, who, as a steer is thrown upon its back, with legs bound, takes a razor-like knife and makes a stroke forward and a half stroke backward upon its throat. After the carcass is dressed it is hung up, and remains thus about four days, the rabbi washing it carefully each day. He then officially marks it as fit for consumption by those of his faith.

REFRIGERATOR CARS.

As in other great industries, the meat industry has been greatly advanced by the invention of special shipping facilities, which in this case, take the form of refrigerator cars. Such a car was patented in 1868, and in September, 1869, the first con-

THE DECOY GOAT.
The sheep follow him blindly into the killing rooms.

signment of fresh beef was shipped from Chicago to Boston. From that date, the modern packing industry may be said to date. When the beef, mutton, or pork has been chilled to the proper temperature, about freezing, it is loaded into cars where that temperature is maintained by the use of ice and salt. The cars must be re-iced every day or so on their journey to eastern cities. So great is the eastward movement of the completed product that several solid trains of refrigerator cars are made up and forwarded every day, which run at a relatively high rate of speed. The great packing companies own their own refrigerator cars. The shipper pays the ordinary freight rate on his product, but is in turn paid a rent for the use of his cars by the railroad.



PREPARING "KOSHER" MEAT.

OTHER PACKING HOUSE ACTIVITIES.

In the early days of beef packing industry, the entire product was salted. Even for some time after the introduction of refrigeration and cold storage treatment, salting of beef was conducted on a large scale. But beginning about 1880 the method of preserving food by the canning process was introduced and has grown to large proportions. In the last census year there were 121,376,837 pounds of corned beef produced. The cattle used for canning purposes are inferior in quality to those used for refrigerator beef. They are known as "Canners" and consist largely of cows and to a small extent of ranch and range steers. It is this product that is called for in such immense quantities by foreign governments for their armies. In the prosecution of this brand of their business, the packing houses manufacture their own cans, print their own labels, make their own shipping cars, boxes, crates, barrels, etc. And some of the canners have developed an extensive business in the production of canned specialties, ready for the table, including soups, entrees, etc. A large concern near Chicago does such an immense business in this way that it is worthy of special mention.

FIFTY ACRES OF FLOOR SPACE USED BY ONE CONCERN.

The cooking and canning facilities of this company cover a space of six acres and include a floor area of fifty acres. The department devoted to cutting meats has a capacity of disposing of 250 cattle per hour, and 15,000 cattle are slaughtered weekly in the plant. Its power-house refrigerator contains eighteen boilers, with a capacity of 750 tons per day.

A LUCIOUS VARIETY OF APPETIZING PREPARATIONS.

Among the delicatessen specialties manufactured by this concern may be mentioned the following: Veal loaf, Melrose pate, luncheon loaf, lunch tongues, ham loaf, beef loaf, Vienna sausage, club-house sausage, sliced smoked beef, hash, potted and deviled meats, turkey and tongue, boneless chicken and ten varieties of soups. These are put up in packages running from one-quarter of a pound to six pounds. This is but one of several vast establishments engaged in the same industry, and in the same locality. Taken together, their product is sufficient to supply the demands of the entire world for goods of this description.

RUMPING AND BACKING.

MISCELLANEOUS PRODUCTS

In former years many independent industries grew up near the packing houses to utilize their by-products. Glue works, fertilizer works, soap factories, oil and tallow works and the like were in a large measure separate from the slaughtering concerns. But as the packing business became more and more concentrated, the large packing houses began to use their by-products themselves. We have seen how naturally they added poultry and eggs to their beef business, but that by no means includes all of their outside activities. They make and can great quantities of mince meat, lard, oleo-

CANNING DEPARTMENT.

SAUSAGE ROCKERS.

COOKING MEATS FOR CANNING.

margarine, butterine, tallow, oils, soaps and fertilizers. It is hard to see the connection of some porducts with packing industry, such as making sandpaper, but that is manufactured to help use the glue.

SAUSAGE.

A very important branch of the business of the great packers is making sausages, of which there is a bewildering variety. To the sausage department go pieces of meat trimmed from the various cuts, or from those parts of the animal, such as the heads, which can not be marketed directly for food. But most of the sausage meat is derived from swine, and from that animal come also the casings for link sausages. The total amount of sausages produced in the last census year was valued at $59,564,582.

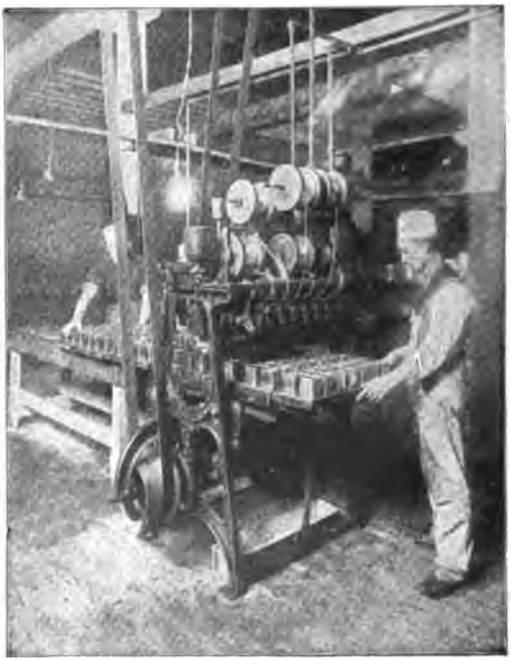
POULTRY FEEDING.

Fattening poultry is a very important industry in England, France and Belgium. In many places, whole families follow poultry fattening as a business. The word "fattening" as used in this connection, is a misnomer. It implies fat or grease, whereas the results aimed at in chicken feeding are directly opposite.

FATTENING GEESE.

In the case of the goose, an abundance of fat or oil is the prime object to be attained. The food necessary to produce this is of a highly carbonaceous, or fat-producing nature; what is termed a very wide ration has this particular effect. The basis of this feed is corn, which has a special tendency to deposit its fat or oil around the internal organs, as well as in layers under the skin. If the feeding be prolonged a sufficient length of time it produces an abnormal growth of the liver. This is not desired in chicken fattening. Layers of fat should not be seen under the skin.

The poultry producers and middle men are awakening to the possibilities in poultry raising, and many new methods of fattening are being tried.



HEADING AND SOLDERING CANS.

There are two ways of feeding, one by machine, and the other from a trough. The only difference in them is that in the latter, the birds, if left to their own inclination, will not consume half as much as they are able to digest and assimilate, and therefore do not take on flesh so rapidly.

MACHINE AND TROUGH FEEDING.

The machine feeding is a very complete operation, and one that a 15-year-old boy, or a woman, can conduct successfully. The birds are cooped, five in a compartment, 20x30 inches in dimensions, there being a row of 50, or more, of these coops, with V-shaped slats for the bottom, and slat or wire fronts, with doors.

If the chickens are to be fed from troughs, these are hung in front, and after morning and night feeding, are removed and cleansed. In machine feeding, the feeder begins the night before by taking a sufficient quantity of sour milk, or buttermilk, and stirring into it what is known as grenadier meal, until it reaches the consistency of thick cream. This is left to stand over night in order to start a slight fermentation, when a diastase is formed that greatly aids digestion.

In the morning the feeder, with a helper to hand him the birds, begins work. As the bird is handed to him he places it under his right elbow, to hold the legs and wings firm, and then opens the mandibles, at the same time depressing the tongue with one finger, to prevent injury, he inserts the tube into the bird's throat. Then, drawing the neck straight, he slides the bird on the tube until, with his right hand on the crop, he feels the end of the tube touch his thumb. He then places his foot on the treadle and gives a slight pressure, when the crop is filled. The quantity is regulated by the age, adaptability and condition of the bird,—one gill being an average for a three-pound bird. This feeding operation is perfectly harmless, and does not cause the birds the slightest pain or inconvenience. On the contrary, they soon learn to look forward to feeding time, the same as if at liberty on the farm, where they all assemble at the usual hour, at the customary feeding place.

This feeding process is repeated morning and night for 21 days, when, after 24 hours' fasting, the bird is killed and dressed for market.

A SUCCESSFUL POULTRY FARM.

One of the most successful poultry farms in the world is located at Ransomville, New York. There are farms upon which more chickens are raised and farms upon which more ducks are raised but none upon which so many fowls—counting both kinds—are raised. It consists of sixty-three acres of light sandy loam. In the feed store house, located along the railroad track, there is an elevator with a capacity of ten thousand bushels, one of the big mixing machines is of a capacity to mix twenty bushels of wet mash at one time.

There is a long laying house, two hundred by sixteen feet, two stories high. On the upper floor about 2,000 leghorn pullets are attending to business. There are two hundred colony houses, one thousand feet of heated brooders houses and three hundred fifteen fireless brooders. The duck brooder house has a capacity of 25,000 ducklings at one time, and there are summer shades and shelters for as many more. The duck houses are immense buildings, one measuring 508 by 36 feet. In all, the buildings contain 300,000 square feet of floor surface.

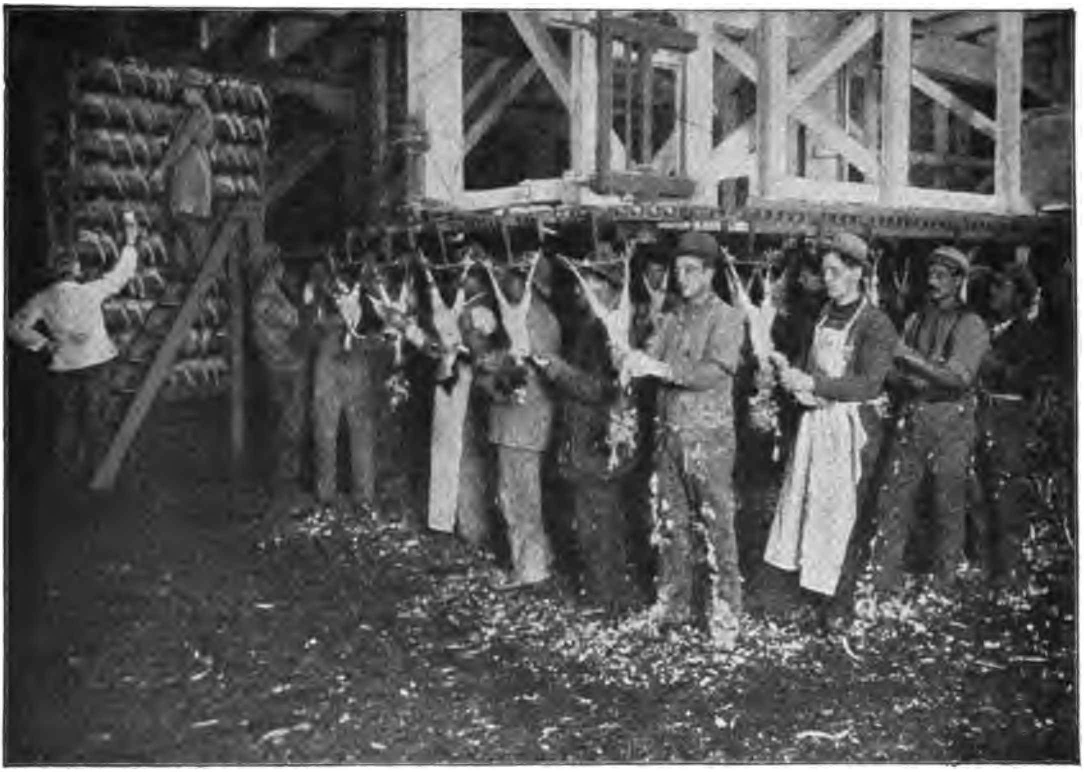
Besides the incubator cellars with brooding houses above, which are believed to be the largest in the world, there are 1500 feet of duck fattening sheds, thirty-six feet wide. There are over ten thousand feet of water pipe laid on the farm. The picking house measures 18 feet by 50 feet, with a loft for the storage of feathers.

POULTRY KILLING BY MACHINERY

Poultry-killing by machinery is the latest innovation made by the big packers at the Union Stock Yards, Chicago. In olden times the method used for slaughtering fowls was to catch them and wring their necks or chop off their heads with an ax or large cleaver. To-day that process has been superseded by one that, while it may not seem humane, is by far the most rapid method ever introduced for killing chickens, ducks, geese or turkeys.

THE FATTENING ROOM.

In describing this twentieth-century method of slaughter, let us begin at the time when the chicken or turkey reaches the packing house. The fowls arrive in car lots and are at once transferred to the "feeding-room," where they are kept for ninety days, to "fill out." Then, if at the end of that period they are found to be fat enough to slaughter, the killing is begun.



KILLING 10,000 CHICKENS, 8,000 DUCKS AND 6,000 TURKEYS PER DAY.

THE KILLING FLOOR.

From the feeding room to the "killing floor" there is a chute through which the fowls are "shot" into a cage which acts as a receptacle on the floor below. Standing directly in front of this cage is a man whose duty is to lift the birds from the cage and place them upon an endless chain, which runs directly in front of him. In placing the fowl upon the endless chain it is turned upside down, both feet being placed in small prongs, spread a sufficient distance apart to make picking possible.

Then a weighted tin can, which weighs about eight ounces, is attached to the bill of the fowl by a "snap." The bird is still alive.

This ends the man's duty at the cage, and the bird moves along to the next man, who sticks an awl into its gullet, which kills it. Then the blood drips down into the weighted can and later finds it way to the fertilizer works, where it is utilized. After this operation the bird continues on its way, passing en route 20 men, each of whom, in turn, removes a few of the feathers as it passes along. Eight of these men are stationed inside a great iron cage, and it is their duty to pick off the best feathers, which are saved and sold to pillow manufacturers.

When the fowl has reached the end of the chain it is taken off by a man and passed over to an inspector. Should there still remain any small feathers upon it, it is taken to a hook which projects from the wall, and there gone over by a "cleaner." At the conclusion of this operation, if the inspector is satisfied, it is placed upon the racks, and within a few minutes, is wheeled into the big coolers. This is what is known as the dry picking process.

THE SCALDING PROCESS.

There is also a scalding process, which is operated upon a similar plan, only that after the bird has been "stuck," it is drawn along on an endless chain, which carries it through a "scalding tub," where the feathers are removed. It then goes into a "cooling tub," and later, finds its way to the cooler.

So rapid is this method of killing fowl, that in a day of ten hours, 10,000 chickens, 8,000 ducks and 6,000 turkeys may be slaughtered. The average wages earned by men in this department are $2.75 per day. It is not an uncommon thing for the packers to have 40,000 fowls in the "feed room" at one time. This enables the shippers to cool and pack to advantage.

TESTING EGGS BY MACHINERY

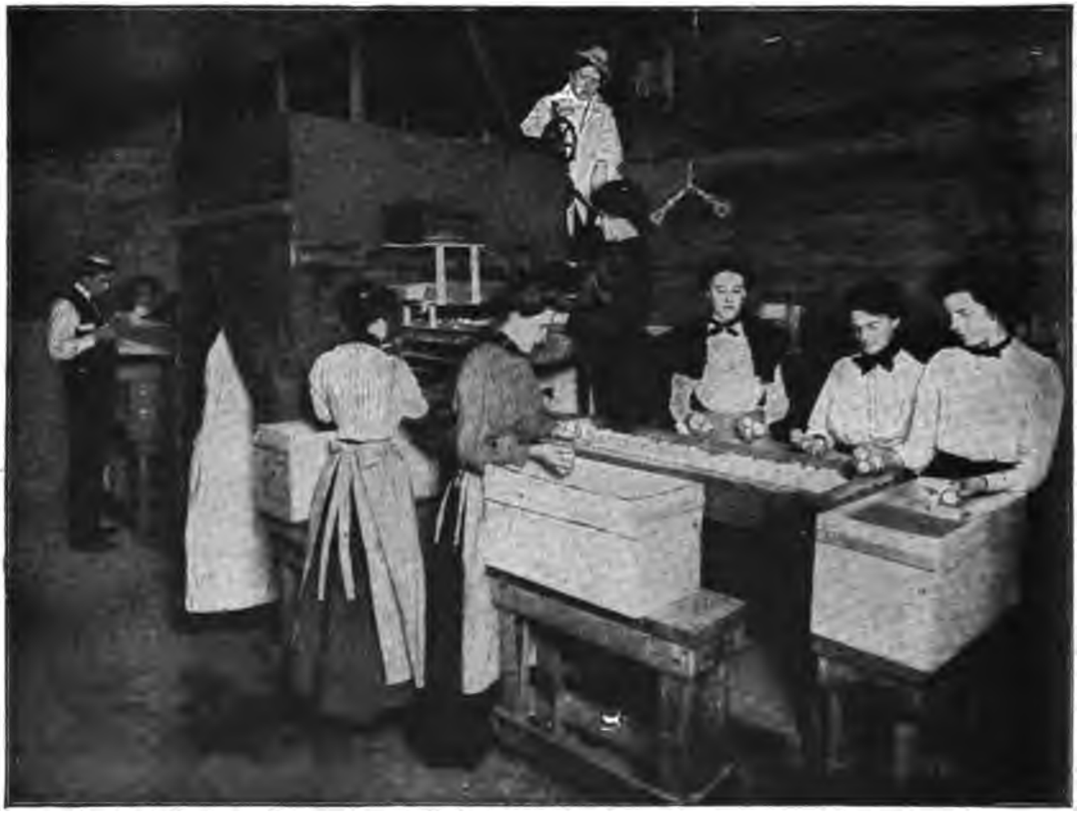
Egg candling by machinery is one of the improvements introduced by the packing houses. In earlier times eggs were held up to the sun, or some light, and thereby tested as to their freshness. This process was considered very slow and far from satisfactory. A few years ago when the big packers began to deal in eggs and poultry, the necessity of an egg candling machine dawned upon the more progressive dealers; a systematic appeal was made to inventors in all parts of the world to produce some kind of a machine that would be rapid and prove a success.

As a result a machine was invented and

put into one of the big packing houses at the Chicago stock yards, and within a week it was running so smoothly that 27,080 eggs were candled in an hour's time.

The egg candler consists of a box or house, eight feet square and ten feet high. Through this runs a shallow trough. Inside the house are a set of rollers, which work in screw fashion, and over these rollers the eggs pass while being inspected. Underneath the rollers is a set of powerful electric arc lights. Two women stand at the feeding end of the candler and pour eggs upon an endless belt that carries them in upon the rollers. As they pass along, the inspector picks out the bad and broken eggs. The former he consigns to the "fertilizer" tank, and the latter to an upper set of rollers, which carries them out to a woman in waiting, who places them in a box marked "broken," or, if they are badly cracked, breaks them into a can.

The eggs that are broken into the can are stirred together, and when the can is filled, it is conveyed to the cooler, where the contents are frozen and later sold to bakeries. The good eggs are placed in cases and put into cold storage. It is not an infrequent thing for the packers to have 15,000,000 eggs in storage. Recent legislation does not now allow indefinite cold storage.



CANDLING AND PACKING EGGS IN A LARGE PACKING HOUSE.

HORSES AND MULES

A MULE FARM.

In 1918 there were 21,563,000 horses on the farms of the United States, and 4,824,000 mules. The value of these animals was nearly three billion dollars. Relatively, horses are nearly twelve times the number of mules in the northern sections of our country, but only one-half times the number of mules in the South. Mules seem especially adapted to work in the agricultural sections of the South. But mule raising is an industry almost exclusively confined to the West Central sections of the United States. The mule will do double the amount of heavy hauling and work on the farm that is possible for the average horse, and requires but two-thirds the food and half the attention demanded by the latter, and can be depended upon, as a rule, for more than double the number of years service.

The greatest horse market in the world is at Dexter Park Pavilion, Union Stock Yards, Chicago. Horses and mules are needed in immense quantities for army purposes and at war times inspectors for foreign governments are busy in this great market gathering up all the horses they can possibly secure and hurrying them to the battlefields.

HORSE MARKET, CHICAGO STOCK YARDS.

MAKING TIN CANS ANNERY.

THE CANNING INDUSTRY

The canning of vegetables, fruits, fish and oysters is an industry which has been developed within the last fifty years, and has now become very important. We have presented some figures showing the great development of beef canning. In other directions, however, it has grown with the same rapid strides. According to the last census there were 3,369 establishments engaged in canning operations, not counting the packing houses. These establishments gave employment to 50,000 wage earners, and the value of their product was $128,772,908.

BOTTLING PICKLES—15,000,000 BOTTLES YEARLY.

SALMON CANNING.

Few realize the magnitude of this industry. The salmon catch in Alaska every year is worth several times the amount paid Russia for what was then supposed to be a barren land. In 1909 the total amount of salmon canned in the United States and Alaska was 278,602,928 pounds. But the Alaska industry is growing rapidly. In 1918 it, alone, was 320,752,000 pounds, nearly 50 per cent increase over the figures for 1909. The salmon canneries are located on the water's edge. The fish are brought to them in scows from the fishing stations on the rivers up which the fish are traveling in great schools from the ocean to the spawning grounds. So abundant are they that 100,000 fine fish have been taken in a single lift of the nets. When the fish are received they are given an ice cold bath, then scaled and dressed. In both cases machinery is used. They are then washed again. A machine cuts them in slices for the cans, which are automatically filled. The cans are tightly soldered, placed in closed steam cookers and subjected to such high temperature that the bones are cooked, as well as the meat. The cans are then tested by blowing or venting, that is, making a small hole in each can for the escape of steam. They are then given another cooking, after which they are thoroughly cleaned, lacquered and labeled and are then ready for the market.

IN A MODERN CANNERY.

OTHER CANNING PRODUCTS.

The salmon canning industry is restricted to the Pacific coast section. Other great canning establishments are located in the fruit and vegetable section of the United States, and the corn canneries in the corn belt. The following statistics show the importance of this branch of the industry. The first three products are given for the last census year obtainable. It should be stated that canned goods are shipped in cases, each case holding 24 cans.

Tomatoes	14,000,000 cases
Corn	13,000,000 cases
Peas	7,000,000 cases
Beans	3,392,864 cases
Various kinds of fruit, such as peaches, etc.	5,501,404 cases

The value of pickles, preserves and sauces was $37,333,747. These figures do not include the canned beef, soups, chickens, etc., produced by the packing houses.

In modern canneries everything is scrupulously clean. All cookers are of aluminum, silver, enamel or copper ware, thoroughly cleansed. Machinery is used in nearly every stage of the process. In peas, for instance, the harvesting, shelling and sorting is all done by machinery. The by-products are all turned to some good account. In modern practice the raw food, soups, fruits, sauces and juices are placed in the can, which has been sterilized and thoroughly cleaned, the cap is soldered on, but a hole is left in each cap for the escape of steam. The cans are then placed in a steam boiler, the cover of which is firmly fastened down, and then the steam is turned on to sterilize the contents by heating to the proper temperature. The little vent hole in the cap is then sealed by a drop of solder. The cooled can is then labeled and ready for the market.

From the foregoing it is seen how true it is that in modern decades one great industry after another has been developed to further the comfort and well-being of the people. The canning industry places in the reach of all, at very cheap rates, salmon from Alaska, fruits from California and Florida, beef products from ranches and farms, and grains and vegetables from the country generally. This industry is but one of the little noticed triumphs of peace, which triumphs alone conduce to the real benefits of man.

THE CORN CROP

Corn is the greatest crop raised by the American people. In 1918 there were produced 2,582,814,000 bushels valued at $3,528,313,000. This amount was raised on 107,494,000 acres. The largest corn crop on record was that of 1912, when the enormous amount of 3,124,746,000 bushels was raised. On investigation we discover that corn is the largest and most valuable crop, takes up the greatest area of land, and provides more employment for farm labor than any other crop we have. Its great use as food for man and animals is, of course, well known. Thousands of cattle from all the western states are yearly shipped to the corn raising states of the Central West to be fattened. It is the abundance of corn in the corn belt states that feed the many million swine, that make possible the enormous output of our packing houses. An idea of the importance of corn as a food supply is gained when we learn that about twenty-five million barrels of corn meal is ground yearly, while the production of hominy and grit is more than 400,000 tons.

BY-PRODUCTS OF CORN.

The by-products of corn are very numerous. Nearly all the starch used in this country, more than 300,000 tons, comes from corn. Glucose is obtained from the same source. Paper and twine are made from the leaves and stalks. The husks are used for packing purposes, for the stuffing of mattresses and couches. The cobs are extensively used in the manufacture of pipes and also for fuel. The pith of the stalk is an excellent packing for battleships, and many thousand tons are utilized for that purpose, thus one of the factors making the American dreadnaughts, the best fighting craft afloat, is raised in the cornfields of the West. A diuretic medicine is extracted from the silk, and a sort of ergot from the smutted ears. Finally, we must not forget that green corn makes a table delicacy so highly valued that over 300,000 tons are yearly canned. Thus this versatile crop feeds man and beast, puts the gloss on laundered clothes, defends our homes, furnishes table luxuries, doctors us when sick and provides the devotee with a meerschaum wherewith to seek solace.

IMPROVED CORN.

It is not out of place to point out that while the total amount of corn raised is, indeed, vast, still the average yield per acre, a little over 27 bushels, is small, and those who have studied improved methods think the yield per acre can easily be doubled.

This is such a vital question that a determined effort is being made. Agricultural eugenics is being brought into play, and by using care in the selection of seeds, corn is being developed in which the average ear is twice as fruitful as those of a few years ago. As showing the possibilities in this direction, we refer to the results of the corn club members in the various states in 1913. The crop was poor that year in the entire country, the average being only 23 bushels to the acre, but these youthful enthusiasts averaged over 74 bushels to the acre, 426 of them made over 100 bushels and 1,078 made over 60 bushels to the acre. This helps solve the problem of how to feed our population of 200,000,000 some decades hence.

THE WHEAT CROP

Wheat is raised so generally over the world that there is not a month of the year that it is not harvest time in some section. The average wheat crop of the world is about 3,500,000,000 bushels. In 1918 the United States raised 917,400,000 bushels on 59,140,000 acres, an average yield of a little less than 16 bushels per acre, the value of the crop at harvest time was $1,874,623,000. The United States is now first in rank among the nations producing wheat. Other lands may in the future dispute this claim. Argentina has immense areas of fertile land and wheat production is increasing. Ukrania and Siberia will also have great areas suitable for the production of wheat. Formerly Russia was called the granery of Europe. But our wheat lands have all been taken up and the only way in which our production will greatly increase in the future is by improved methods of production. Great results will doubtless be achieved in that direction. There is no reason why the average yield per acre should not very considerably increase. Much will be done by improved tillage, the use of fertilizers, etc. By these methods alone France, England and Germany raise far more wheat per acre than we do. But agricultural eugenics is a promising field. That means the production of improved breeds of wheat, which can be developed on exactly the same principles that live stock is improved, the same practice that is so rapidly improving our corn crop. This is a matter of such great importance that Minnesota, through its agricultural experimental stations, has conducted a series of interesting experiments, which have led to valuable results.

NEW BREEDS OF WHEAT.

The purpose of the experiments was to develop new breeds of wheat, and by the process of breeding and careful selection a product has been evolved which not only stands every test of climatic conditions, but also possesses every essential food quality. The new breeds have also stood the test of crop raising conditions on the farm, and the results will doubtless be a bettering of wheat harvesting, not only in the section where the experiments were carried on, but in the wheat area of the whole world; it will result in the addition of millions of dollars to the value of real estate in the wheat raising countries.

The process followed necessitated removing the pollen from the flower of one grade of wheat to the stigma of the flower of another. Two breeds of good character are selected in the experiments, one for the father, the other for the mother of the new breed. About four o'clock in the morning, when the florets of the wheat open, the operation is performed, and then the head of the wheat is enveloped in a sack of tissue paper, in order to keep out insects. It may be that some of the good qualities of one wheat are mingled with the bad qualities of another, when the harvest of the new breeds is garnered. Painstaking work, however, has finally resulted in new and much stronger varieties, and now that they have been secured, they will go on reproducing themselves, to the benefit of mankind.

In the process of selection, only the hardiest grades were selected for new breeding. The best start in life is accorded the new wheat, and only the best of the new grades are kept. Some kinds were found to be too heavy and rank in growth, thus tending to "lodging" or falling during periods of rain and much moisture. Others were found to be especially susceptible to wheat diseases. Still others showed a deficiency in food quality. In all, over 500 new grades were thrown out in the early tests, and less than a dozen were retained for the practical farm tests.

Something of the practical results of the experiments may be learned from the prolific qualities shown. In tests where the new breeds were grown side by side with old wheat, there was an increase in some cases of from eight to twelve bushels an acre. The new wheat that has been best tested so far, is called Minnesota No. 163, and shows an average yield of 42.7 bushels per acre. Of eight grades tested in small experiments, none averaged less than 19.5 bushels per acre, while the average of six breeds was 27 bushels, and the average of all averages showed 28.1 bushels.

Tests made comparing the new breeds with Fife wheat—one of the old standard wheats—showed an increase of four and one-half bushels, and an increase of one and one-half bushels an acre was made over all wheats compared. From these tests it is concluded that the new breeds will excel the old by at least two bushels, although, when it is considered that under ordinary conditions the old breeds develop only about thirteen to fifteen bushels an acre, this seems too small. And yet, when it is further considered that in the Dakotas and Minnesota about 15,000,000 acres are annually under cultivation this increase means an additional yield of 30,000,000 bushels. At $1.50 a bushel, the annual increase in wealth to the farmers of three states only should be about $45,000,000. When all these things are considered, it may be readily seen that humanity is a great gainer; for, not only is the greatest source of food supply made more hardy, more certain and more safe, but the wealth of the world is certain shortly to be greatly enhanced.

If this proportion of increased production be applied to the entire wheat-growing area of the country, the results to agriculturists would be of almost incalculable benefit.

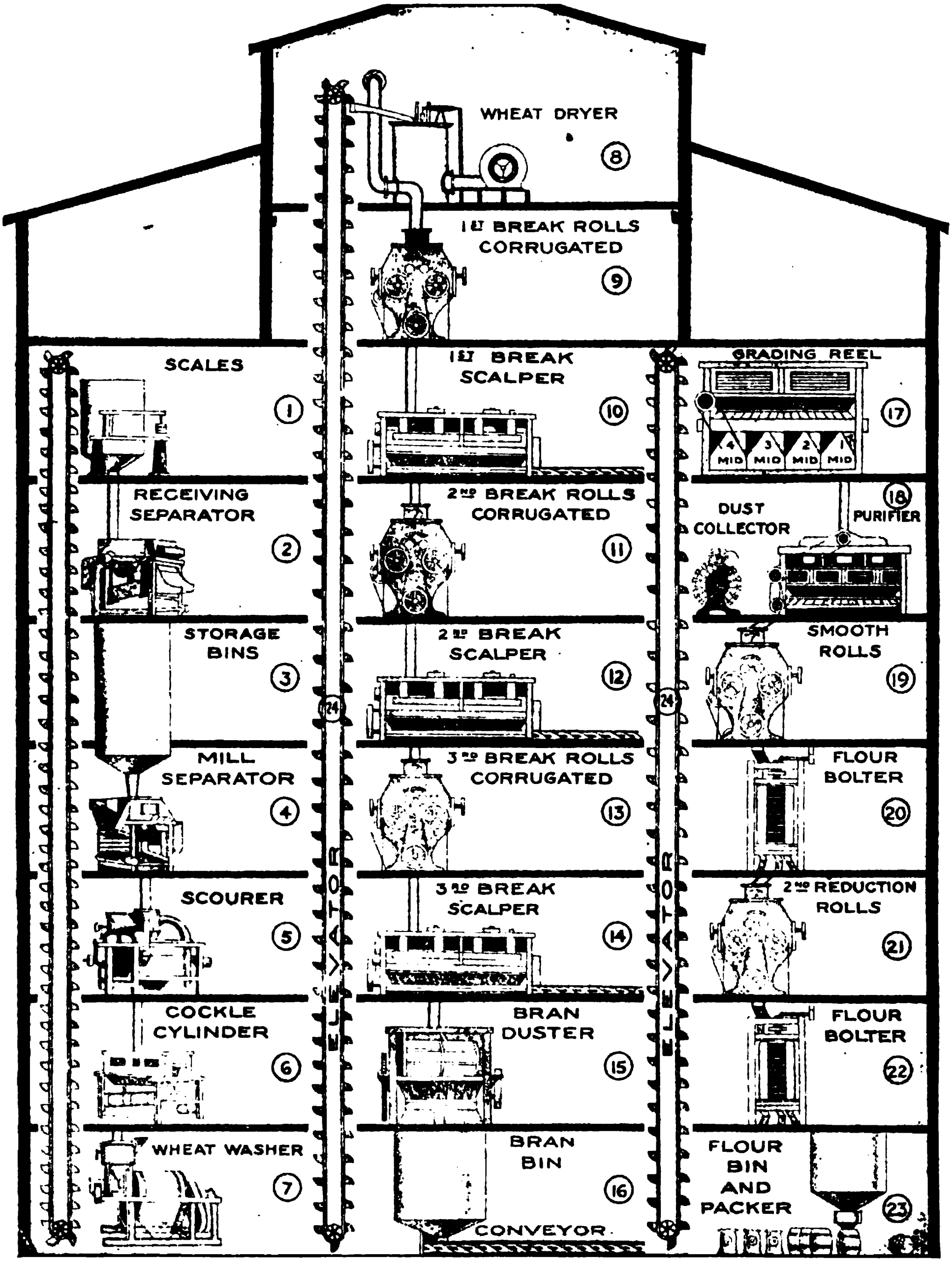
But the enhancement of the prosperity of the farmer through this multiplication of the profits of his labor is not the only cause for congratulation over the success of these experiments. As bread is verily the staff of life, and constitutes almost the main dependence of millions of lowly families, whose lot is ever on the verge of want, whatever tends to maintain the supply of this great staple up to the utmost possible demand, at rates within the means of needy multitudes, will be hailed as a boon.

MARKETING WHEAT.

The elevators of our grain sections are the result of efforts to market wheat. No other country has evolved such a convenient system. In almost every town in the great wheat sections, particularly in Minnesota and the Dakotas, there is an elevator connected with Minneapolis and Duluth, the two great wheat receiving points, whence it is distributed to the merchant flouring mills of the northwest or shipped eastward by lake and rail on its way to the markets of the world. In Minneapolis there are about fifty elevator companies, operating about two thousand country houses, which have a combined storage capacity of about 50,000,000 bushels of wheat. In addition, there are in Minneapolis a great many terminal elevators with a combined capacity of about 30,000,000. One elevator alone in that city holds over 2,000,000 bushels. While these great grain handling companies are not combined, yet working together harmoniously, they virtually control the grain trade of the northwest. Each great elevator company has its local managers in the towns where ele- at Minneapolis every night, or if the market vators are located. When the new crop moves the wheels of commerce begin to hum through the whole northwest, and trade and railway traffic are affected all the way to the eastern seaboard. How to move the new crop is a yearly financial problem for the banks of the country. Changes in the price of wheat are sent out from the offices is feverish the buyers are notified from time to time by telegraph.

PILLSBURY "A" MILL, MINNEAPOLIS, MINN.—CAPACITY, 15,000 BARRELS PER DAY.

The wheat received at Minneapolis divides into two great streams, one of which is intended for the manufacturing flour mills of the Northwest, especially those of Minneapolis, which is the greatest milling center in the world, and there is located the greatest flouring mill in the world. When running to its capacity, it can grind several train loads of wheat a day. Like all important manufacturing processes, the manufacture of flour has been greatly improved in recent decades. The number of flouring mills in Minneapolis is perhaps not any greater than it was a number of years ago, but the present annual output of 15,-



Cross Section of a Modern Mill

To understand this cross section follow the course of wheat from the time the grain arrives from the elevator at the top of the mill (number 1 to the left) by means of diagram until it arrives in the form of flour at the lower right hand corner (number 23). Notice that the wheat or partially ground flour is elevated to the top of each separate tier and then gravity carries it from floor to floor.

000,000 barrels exceeds that of 20 years ago by more than 650 per cent, and this in the face of the fact that some of the larger plants manufacture, in addition to their flour product, immense quantities of the different kinds of breakfast cereals now so commonly used. The gain in capacity is due to the fact that most of the mills have been enlarged from time to time and equipped with the very best modern machinery.

A MAMMOTH FLOUR MILL.

As an illustration, the Pillsbury mill was constructed in 1880 with a daily capacity of 5,000 barrels, but it has been improved until its capacity is now 14,000 barrels. This is the largest flour mill in the world.

MECHANICAL TRIUMPHS IN A GREAT FLOUR MILL.

The flour mills of the present are a wonderful triumph of scientific industry, and when in full operation one of them seems almost a thing of life. The wheat is shoveled by machinery from the car into a large pit, from which it is taken into the endless machinery of the mill. It is then hurried on, this way and that, through secret passages, from one side of the big mill to the other, now up, now down, through this machine and that, until finally every kernel is divided into as many component parts as the processes number, and each part drops into its own receptacle. It has been forced through all these by the mill's own machinery, without having been touched by human hands or seen by human eyes. No one is watching to see if it takes the proper course, or if any part of the machinery does its work; a lever is pulled which conducts a portion of the Mississippi upon a big wheel, and all the intricate machinery in the giant mill responds with a harmony that seems almost human.

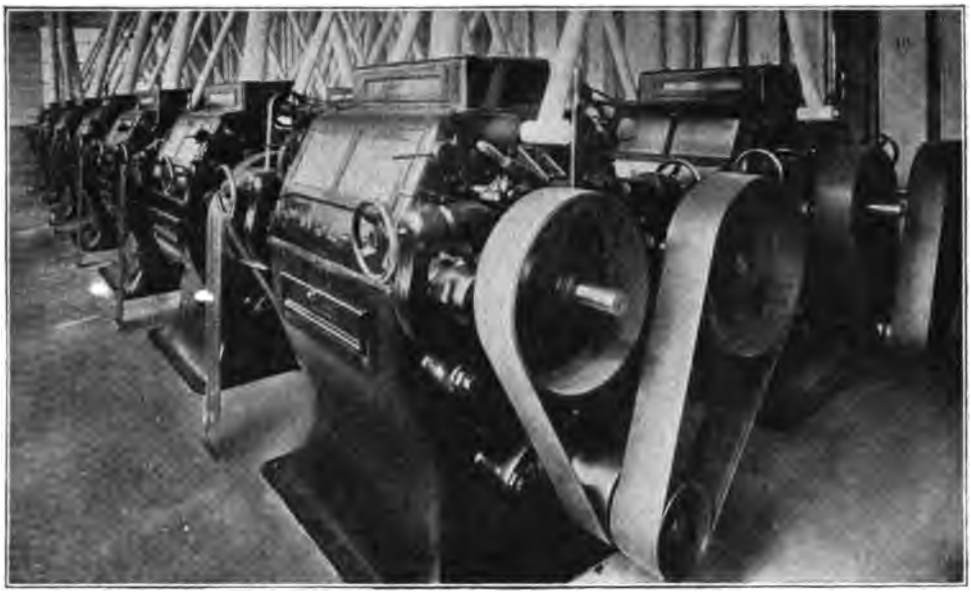
DECREASED MILLING PRICE.

Incidentally it may be mentioned that while the mills have been increasing their capacity and improving their processes the profit per barrel has been gradually decreasing. In 1880 the average profit on a barrel of flour was about 75 cents, while now the millers think themselves fortunate when they figure up their profits and find that about 20 cents is realized after all expenses have been paid.

It must not be inferred from this that the business of milling has reached a crisis, or that the meager profits on a barrel of flour, as compared with those of the early days, have affected the milling industry. The price per barrel rises or falls through natural causes, but a loss in profit has been, perhaps, more than offset by the increased capacity of the mills through the introduction of modern machinery. The lucrativeness of all the large manufacturing industries to-day depends upon the great volume of the output rather than upon the large percentages of profit.

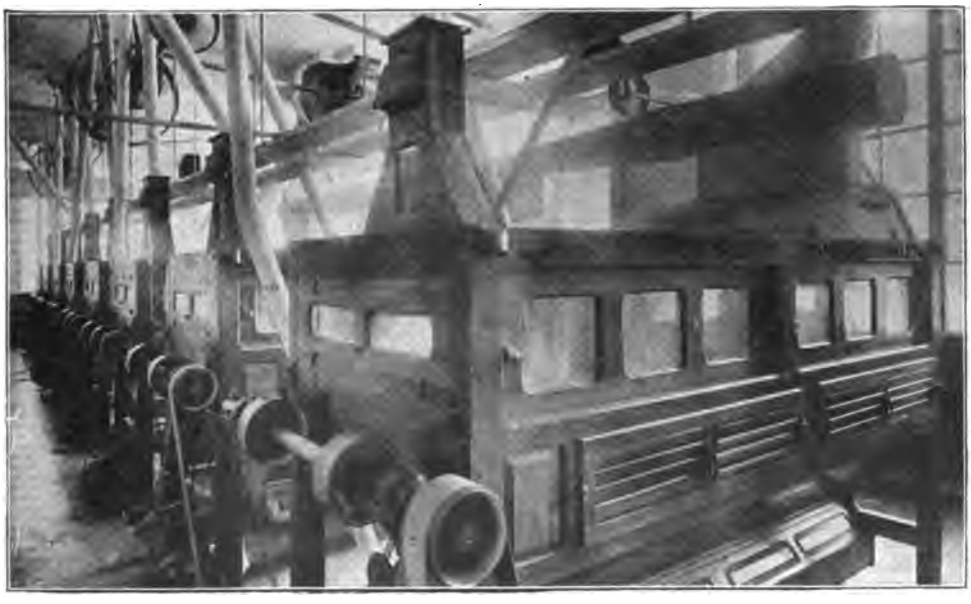
THE NEW MONSTER ELEVATORS.

Twenty years ago a car carried about four hundred bushels, but those now being built carry twelve hundred bushels. The building of new roads and improvements in methods of transportation have also reduced the price of grain carrying to terminal points in Minnesota nearly, if not quite, 66 per cent. But little more than ten years ago it cost twenty-six cents a hundred pounds to ship wheat from Minneapolis to Chicago; to-day the same



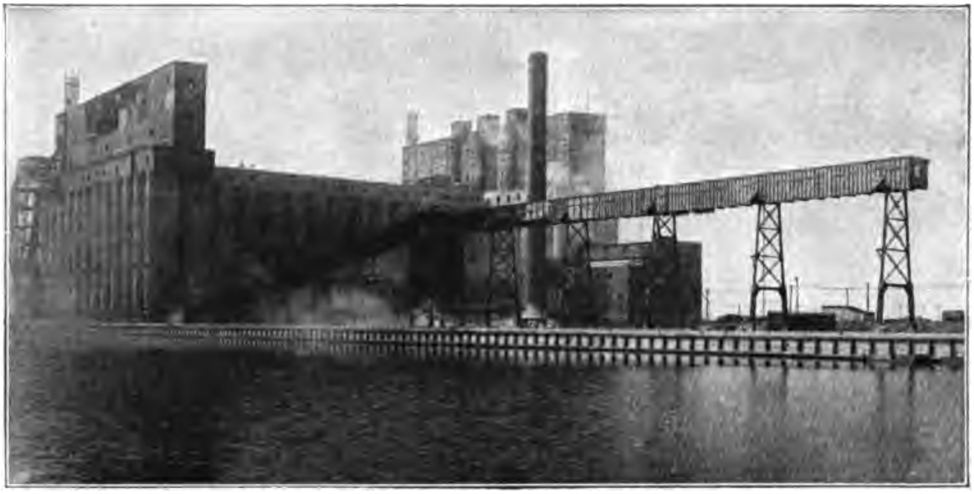
One Set of Rollers

These rollers represent the old fashioned millstones. There are five sets in all. The first rolls simply crack the outer coat off of the wheat. The last rolls grind the midlings.



Final Bolting

Finally as a last precaution and in addition to all previous processes, the flour is again sifted through finest silk bolting cloth. In these various reductions about 70 per cent of the grain is saved for food and 30 per cent becomes bran and shorts.



A Modern Elevator

Near the wharves of most large cities along the coast and on the Great Lakes, and on the railroad lines in many inland towns and cities, you will see very tall buildings of a peculiar shape where grain is stored. It is necessary to have warehouses built for this purpose, since grain when shipped in large quantities cannot always be immediately used.

Special Machinery Under Elevator

Special machinery has been devised for handling the vast quantities of grain with a minimum amount of labor, and a car or a great boat load of wheat may be unloaded in a fraction of the time necessary if it was necessary to depend on the strength of men alone.

amount is carried for ten cents. Twenty years ago it cost from 15 to 18 cents a bushel to ship wheat from Duluth to Buffalo; to-day a rate of three cents a bushel would be excessive. At that time a good cargo was 30,000 bushels; now those figures may be multiplied by ten. A great grain market, created and fostered by an extensive system like that at Minneapolis, has made a radical change in the problem of storage construction.

THE MODERN TERMINAL ELEVATOR.

The modern terminal elevator, which is a child of necessity, has reached its present development through as many evolutions, perhaps, as those of the modern flour mill. There has been no change in recent years in the methods of operating a terminal elevator, except that in some cases electricity has been substituted for steam as power, and that in a few instances, the grain is conveyed by pneumatic tubes .instead of by cup-belts. But the shape and material of the structures have been completely revolutionized. Some years ago, in this process of evolution, steel began to supplant wood as building material, and the Great Northern steel elevator of Duluth, which is capable of storing more grain under one roof than any other elevator in the world, is made wholly of steel.

OUTSIDE STORAGE TANKS.

Cylindrical tanks for storage next began to be erected outside of and separate from the elevator, instead of the long bins in the elevator proper. Some are made of steel, some of tiling and some of cement. A wide, flat, rubber belt carries the grain from the upper story of the elevating plant, or working house, to the tanks, and discharges it through a hole in the roof. When grain is shipped from a tank it is conveyed from the bottom of the structure through a subterranean passage to the elevator pit on a belt similar to the overhead belt which carries it to the tank. From the pit it is elevated to the shipping floor and spouted to a car.

It is possible to keep grain making this circuit continuously, from the pit to the top of the "working house" by the cup-belt to the top of the tank by the horizontal belt, to the bottom of the tank by gravitation, and then to the elevator pit again by the underground passage. Sometimes, damp grain is treated in this way to dry it. A conveying belt is three feet wide, and the stream of grain which falls upon its surface is from six to seven inches in diameter. A six-inch stream will empty a tank of about five thousand bushels of wheat in an hour. Each plant consists of a dozen of these tanks, more or less, and their capacity is about 100,000 bushels each. These are much more expensive than the old-style houses, but the extra expense is offset in a few years' time by the saving in insurance. Being strictly fireproof no insurance is carried on the structure or its contents. Thus, while the mills have passed from the primitive to the modern era, and the methods of transportation have been improved, the elevators have kept pace with these improvements.

STATE SUPERVISION OF TERMINAL GRAIN MARKETS.

In addition to the great industries already mentioned, Minnesota has a system of state supervision over the grain market at its terminal elevators, in which the grain dealers of the whole world are vitally interested. Other states adopt similar measures, but do not compare in efficiency with this big cereal state of the northwest.

THE COTTON INDUSTRY

A COTTON COMPRESS.

Cotton is one of the world's most important crops. From its fiber is manufactured clothing for the body; from its seeds is obtained an oil used for many culinary purposes; finally, the cotton itself is used in the manufacture of high explosives, and to such an extent that it is classed among the contrabands of war. Cotton, however, flourishes in comparatively limited sections, though widely scattered in warm temperate and torrid lands. The world at present raises about 25,000,000 bales, averaging about 500 pounds each. Of this amount the United States produces on an average just about half, raising in 1918 11,700,000 bales. The world's demand for cotton, like the demand for iron, is constantly increasing, and it is probable that before many decades at least double its present supply will be required. But the United States can easily double its present production, for the largest crop yet raised in this country, that of 1911, was raised on only about 10 per cent of our available cotton producing territory. The period from 1860 to 1865—the period of our Civil War—when Europe was deprived of our cotton, is known in Europe as the time of the "cotton famine." It is interesting to compare the pre-war prices averaging around ten cents a pound, with the prices then prevalent. In 1861 the price reached 38 cents a pound, the next year it had almost doubled, being 69 cents. It rose to 93 cents in 1863 and touched high water mark in 1864, bringing $1.90 a pound. It is estimated that at present prices for labor, fertilizers, etc., cotton costs about 8 cents a pound to raise. Experience has shown that in cotton growing sections only those farmers who practice diversified agriculture are prosperous. A failure to observe this rule is accountable for the backward state of agriculture in the South, which is now quite generally corrected, and that section is becoming very prosperous.

COTTON CULTURE

Herodotus, surnamed the Father of History, who was born B. C. 484, traveled through Europe, Asia and Africa, and when in India, saw and described the cotton plant. He says: "The wild trees in that country bear for their fruit fleeces surpassing those of sheep in beauty and excellence, and the natives clothe themselves in cloths made therefrom."

LOADING COTTON, NEW ORLEANS.

SELF PERPETUATED IN ANCIENT TIMES.

In those ancient times the cotton plant perpetuated its own species through the dispersion of its seeds by the winds. The root of the plant is top-shaped, and penetrates very deeply into the earth.

VARIETIES OF COTTON IN AMERICA.

In America are no less than 130 varieties of cotton. Among the chief commercial types is the "Gossypium Barbadense," which is indigenous to the Lesser Antilles, and is extensively cultivated in the United States, as well as in the West India Islands, Central America, Western Africa, Bourbon, Egypt, Australia and the East Indies.

BRAZILIAN COTTON.

Another variety of cotton is cultivated very extensively in the coast region of Brazil. Just after the Civil War the cotton export from Brazil was over 100,000,-

000 pounds per year. It afterwards fell to 50,000,000.

Pernambuco, Parahyba and Alagoas are the chief producers of cotton in Brazil, although its culture extends as far south as Rio Grande do Sul. It requires little labor in that region, and a very limited capital is sufficient.

THE COTTON PLANT—SOME OF THE BOLLS ARE OPENING.

The height of the species common to the United States varies from three to four feet, if cultivated as an annual, and from six to eight feet, if allowed to grow as a perennial. When in full leaf and flower, it is a most graceful looking plant. Yarns having the finest counts, as they are called, are all spun from Sea Islands, which belongs to this class.

A THREAD 160 MILES LONG.

A single pound of this cotton is often spun in a thread 160 miles long.

In the United States cotton is cultivated in North Carolina, South Carolina, Georgia, Florida, Arkansas, Tennessee, Alabama, Mississippi, Louisiana and Texas.

In the beginning of the 19th century South Carolina produced more cotton than any other state. Fifty years later, Alabama went to the front. Ten years later, Mississippi led, but in 1918 Texas was first with 3,115,000 bales.

COTTON PICKING.

Late in July, or early in August, the cotton pods begin to show a few ripe open bolls, and the sacks and baskets are made ready for picking. Picking cotton must be done under a shining sun, and is very wearisome work. After being picked it must be carried to the gin house before the night dews touch it.

GINNING COTTON.

Ginning cotton consists in separating the cotton from its seed; as the cotton is picked, and before it is ginned, it is known as seed cotton. The cotton plant is the only fiber plant in which the lint adheres to the seed, though in the long-staple Sea Island cotton, and the cotton raised in Egypt, the lint does not cling as tenaciously to the seed as in the common short staple. Probably no invention ever caused such a rapid development of the industry with which it was associated as that of the Cotton Gin, invented by Eli Whitney in 1794. The substantial features of the machine are the same to-day, but of course the whole process of handling cotton has been revolutionized by improvements in recent decades, in keeping with improvements in other great industries. Picking cotton is still done by hand, but from the time the seed cotton arrives in a wagon at the gin, until it is delivered, a perfect bale on the platform, ready to go to the compressors, it is handled entirely by machinery. It is unloded from the wagon by suction created by an exhaust fan connected with a vacuum separator and cleaner, by which the dust, sand and leaf trash is separated from the cotton. After being thus freed from impurities the cotton is conveyed through a distributor to the Automatic gin feeders.

THE BUSY COTTON PICKING TIME.

In the gins the seed is separated from the lint and is blown into either the seed room or into the wagon waiting to receive it. The cotton is then conducted by a flue system to a condensor, where it is baled. At present cotton intended for export is re-baled in compressors. That is, it is put under great pressure and reduced in size to the standard size of 54 inches in length, from 24 to 27 inches in breadth, from 28 to 30 inches in thickness. But improvements under way will eventually result in eliminating this step. That is, the bale when first produced will be pressed to these dimensions. What are known as the round bales already have achieved this end.

COTTON SEED.

There are many people now living in the cotton growing states who can recall the time when cotton seed was not only useless but an actual danger to health by its decay. To-day the cotton seed crop in the South is valued in the neighborhood of $100,000,000 yearly. The amount of seed produced varies with the crop. In 1918 almost five million tons were secured. It is surprising the valuable products now obtained from the seed. It is first run through a hulling machine which cuts it to pieces and screens the hulls from the meat. Formerly the hulls were used as fuel, but they are now ground with cotton seed meal and form a very nutritious food for stock, and hundreds of thousands of head of cattle are fattened from the same. A ton of seed is just about half hulls and half meat, so that several million tons of hulls and meat are secured yearly. From the meat is extracted a valuable oil, known as cotton seed oil. A ton of meats will produce just about eighty gallons of oil. Large amounts of this oil are now used by packing houses in the manufacture of various substitutes for lard. It is also largely used in the manufacture of butterine and oleomargarine; and to make many grades of soap. Candles, glycerine and many other articles are manufactured in part from cotton seed oil.

A COTTON GIN.

But after the oil has been extracted there are left about 1,400 pounds of cotton seed cake, which, when ground, is known as cotton seed meal. This in itself is a very valuable fertilizer, or when used as a mixed ration is one of the most valuable of cattle foods, and for this purpose it is once more combined with the hulls from which it was separated. So valuable has the cotton seed crop become that it is bought, sold and quoted in markets of the South as is grain in the North. The cotton crop in its two great divisions of cotton lint and cotton seed represents an industry whose product is now approaching a yearly value of two billion dollars, being in 1918, $1,700,000,000.

SUGAR INDUSTRY

The per capita consumption of sugar in the United States is greater than in any other country in the world. According to the last census we produced of cane sugar 326,358 long tons, beet sugar 501,682 long tons, maple sugar, 6,362 long tons; a total amount of 834,902 long tons. But we made that do only by importing three times as much. In this connection, it is interesting to note that we also made 24,587,581 gallons of molasses; 4,106,418 gallons of maple syrup; 16,532,381 gallons of sorghum and immense quantities of glucose and grape sugar. Louisiana produces nearly all the cane sugar made in the United States. In 1918 that state produced 233,000 short tons; all other states only 2,240 short tons. The production of cane sugar in the United States will probably not increase. It will be noticed that there was considerable decrease from 1909 to 1918. It costs nearly twice as much to produce sugar in Louisiana as it does in Cuba. At present there are three principal varieties of cane grown in Louisiana, the purple and striped Java and a greenish yellow cane.

The area of cane in Louisiana is in the neighborhood of 250,000 acres. From four to six tons of cane are necessary to plant an acre. It is common to plant a few acres, use the entire crop of the next year in planting a larger area, and take the entire crop of the third year to supply the whole plantation. Several sugar houses in Louisiana work from 1,000 to 1,500 tons of cane daily or from 60,000 to 70,000 tons during the season of from 60 to 90 days. The cane, which grows best in a sandy loam, does not seed. It produces a crop of 20 to 30 tons per acre. Where used only for sugar, the fodder and tops, the bagasse from the mill and the ashes from the sugar house are carefully returned to the soil. In some localities, however, the waste is being utilized in a new way, as hereafter mentioned.

PROCESS OF MAKING SUGAR.

From the field cane is carried to a moving platform which drops it end on into a chute abutting upon a three-roller mill giving two pressures. A conveyor then takes the crusher cane to a second mill where it gets a final squeezing and is ejected in a pretty dry state (called bagasse). This is conveyed by a third carrier to the bagasse furnace, where it is consumed as fuel and supplies steam power and steam heat to the sugar house.

The juice as it runs from the mill is strained and limed and passes into the clarifiers where the temperature is raised and the lighter impurities, coming to the surface, are skimmed off, while the heavier sink to the bottom. The clear juice is then drawn off and sent to the boiling-down apparatus. There it is concentrated into a syrup which is boiled to a grain in the vacuum pan.

SEPARATING THE SUGAR FROM THE MOLASSES.

The contents of the pan are then sent to the centrifugal machines, which separate

SUGAR CANE.

the sugar from the molasses and the former is put into barrels. The latter undergoes another process before the final molasses is produced.

BEET SUGAR.

The production of beet sugar in the U. S. is a recent industry, but it is already of mammoth proportions. The amount produced far exceeds that of cane sugar and is increasing with great rapidity. According to the last statistics, there were 96 beet sugar factories in the United States, representing an outlay of $200,000,000. In 1918 there was produced 740,000 short tons of beet sugar, valued at $118,000,000, and $2,000,000 worth of other products. From 1899 to 1918 the beet sugar production increased 800 per cent. But the production is still increasing, and with great rapidity. This implies a corresponding increase in the production of beets. In 1899 there were 794,658 tons of beets raised, but in 1918 the amount had increased to 5,625,000 short tons.

Since the raising of beets is purely an agricultural problem, it is evident that farmers are greatly interested in these results. Statistics show that 664,700 acres of land were devoted to raising beets, the average yield per acre being nine and a half tons. The value of the beets varies between five and seven dollars per ton. A great deal of labor is required at certain parts of the season, but the profits are good. The yield of beets per acre will doubtless increase as improved varieties are introduced—some lands produced over 20 tons to the acre.

It is not all sections of the country that raise the beets successfully. It is a narrow belt starting from the Hudson River west, taking in Southern New York, Northern Pennsylvania and Ohio, bending north to take in Southern Michigan, Wisconsin and

CUTTING SORGHUM CANE IN NEBRASKA.

Minnesota, all of South Dakota, thence west to the coast. But there are many sections in that belt where, for some reason, beets do not flourish. The irrigated lands of the West are showing remarkable results, and the far larger part of the great increase noted was in that section.

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A BEET SUGAR FACTORY.

SEEDS FROM GERMANY.

Germany was the home of the sugar beet industry, and our production of sugar looks very small beside their production of 2,732,180 long tons in 1913. Most of our beet seed was imported from that country, but of late years we have raised our own seed. High-grade seed is grown only from mother beets, every one of which is examined for shape, character of leaf, and keeping quality, and tested for sugar contents. Bearing in mind the immense amount of sugar we import, it would seem as if the United States could profitably manufacture several times the amount of beet sugar it does. We may, therefore, look for the beet sugar industry to continue to increase, and rapidly so, for decades to come. It will ultimately rank as one of our greatest industries. Improved varieties of beets will be in keeping with improved corn, wheat,

Stock Fattening on Sugar Beet Pulp

American farmers have only lately begun to recognize the high feeding value of sugar beet pulp, and now millions of tons of what was formerly considered waste are utilized in a highly profitable manner as feed for cattle and sheep.

A Beet Sugar Factory

Thousands of acres surrounding this factory are devoted to raising beets. Large stock yards are located around the factory.

Manufacturing Beet Sugar

The damp white crystals separated from the syrup by the centrifugal machines are conveyed to horizontal revolving drums about 25 feet long and 5 to 6 feet in diameter. These drums have paddles which thoroughly stir the sugar.

Putting Sugar Into Sacks

After the sugar is thoroughly dried it drops to the sacking room where it passes through a chute directly into the sack. The flow is automatically cut off with each hundred pounds. Then an endless belt conveyor passes the upright sack past the sewing machine and it is sealed.

potatoes and fruits. Instead of 96 sugar beet factories, we will doubtless require a couple of hundred of them. This will mean great prosperity in all sections when sugar beets can be raised.

SCENE IN A MAPLE SUGAR CAMP.

SUGAR FROM OTHER SOURCES.

Maple sugar and maple syrup are produced in the northern portions of our country. Since over fourteen million pounds of sugar and over four million gallons of syrup were produced in the last census year, our maple tree harvest must not be overlooked in figuring on the supplies necessary to fill our demands for sugar. Neither must we forget sorghum, that variety of cane which grows quite generally in our corn belt section, and which yielded over sixteen and a half million gallons of syrup. We must also recall that from our common corn we manufactured 343,598 long tons of glucose, which takes the place of sugar in many ways, especially in confectionery.

THE TOBACCO INDUSTRY

Few know the great acreage given to the growth of tobacco in the United States, the immense crop produced, the farm value of the crop, or the market value of the manufactured products. The fiscal year 1918 the internal revenue collected by the government on manufactured tobacco was $156,188,660. The following figures give the amount and variety of the manufactured products:

Cigars, number	8,731,919,000
Cigarettes, number	36,959,334,000
Chewing and smoking tobacco, pounds............	417,647,000
Snuff, pounds..............	3,503,561

THE CROP IN THE UNITED STATES.

Like all other crops, the amount grown varies from year to year. The crop of 1918 was the largest yet raised in the United States, being 1,340,000,000 pounds. This crop was raised on 1,549,000 acres of land, and was valued at the farm at considerably over $300,000,000. It will be noticed that the average return per acre cultivated was just about $200.00. In general terms, the United States produces just about one-third of the total amount raised in the world, which approaches three billion pounds—being in 1912, 2,835,740,000 pounds. Of the various states raising tobacco, Kentucky is far in the lead, with North Carolina second and Virginia third. According to the last census, there were 15,822 establishments engaged in the manufacturing of tobacco, giving employment to 166,819 wage earners, and the market value of their product was $41,695,104.

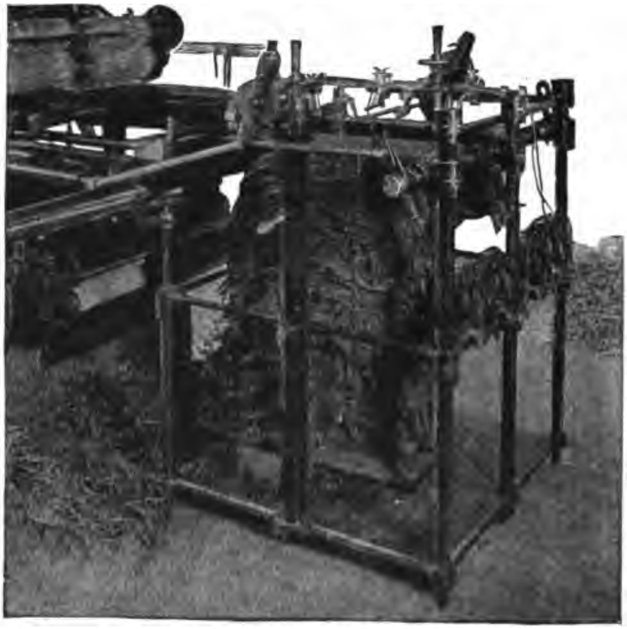
HAND-MADE CIGARS.

Tobacco is native in the warm, temperate and tropical sections of America. It was carried by the Spaniards and early settlers to Europe. The streets, gardens and public squares of Jamestown were planted with tobacco as early as 1615. In 1619, 20,000 pounds were shipped to England. In the three centuries since that time, tobacco has spread very widely over the earth. It is known everywhere, being exceeded only by salt in wide distribution and general consumption. It is the most widely known narcotic in the world. Varieties having special points are developed in different sections of the world. In some countries, its cultivation and manufacture is made a government monopoly.

Its importance as a crop in the United States is such that the Department of Agriculture has spent a great deal of money trying to acclimate choice varieties of tobacco. Tobacco used as wrappers on fine cigars, grown in the Connecticut Valley, was introduced from Sumatra. In other sections tobacco from Cuba has been introduced.

FACTORY PRODUCTION.

In large factories machinery is used in manufacturing cigars, but a very large number of cigars are made principally by hand in small establishments, which are very numerous. It is claimed that the best cigars are still made by hand. A set of molds, a hand press and a sharp knife are the only tools needed by an expert cigarmaker. Cigarette making has concentrated in large factories and everything is done by machinery, some of the most ingenious machines ever constructed being employed. Both the paper and tobacco are fed into a machine, to emerge a few minutes later as complete cigarettes, nicely packed in a box. In preparing smoking tobacco, the paper and tobacco are fed into a machine, which in a day's time turns out 30,000 neatly wrapped packages all of the same weight, ready for shipment.



TOBACCO STEMMING MACHINE. IT DISCARDS STEMS—PILES UP THE LEAVES.

TOBACCO RAISING.

For cigar tobacco, the plants are grown rather close together, 14 inches in Florida giving leaves of desired size, quality and appearance. For manufacturing tobacco the distance should be greater. Cultivation should be frequent and shallow. When the production of seed is not desired the plants are topped to prevent flowering, so that their whole strength may be used in growing leaves. Fertilizers containing potash are the best for tobacco lands.

THE OLIVE INDUSTRY

THE OLIVE INDUSTRY.

In Southern California is located the largest olive orchard in the world. There are also others that outclass the olive groves of the Mediterranean in size.

Olive orchards in Italy are looked upon as perpetual fountains of wealth. It is more than a hundred years since the first of these orchards were planted by the Spanish mission fathers of California, who did so much to influence the early industries and life of that state when it was a part of Spanish Mexico. The success of their olive tree cultivation proved the adaptability of the climate, and ever since that time the industry has been steadily growing. From the olives that are grown in California is produced from 24 to 31 per cent of oil. They are richer and more palatable when pickled than the imported green olives from Italy. The demand for ripe olives is steadily on the increase, and in the year 1902 it was about 30 per cent more than in the preceding year.

THE OLIVE TREE MORE VALUABLE WHEN OLD.

The older the olive tree becomes, the more valuable it is to its owner, because of its prolific bearing. The wood of olive trees is highly prized by cabinet makers, for it is exceedingly hard and susceptible to a high polish.

THE WORLD'S BIGGEST OLIVE ORCHARD.

This mammoth enterprise is located at Sylmar, twenty miles from Los Angeles, California, in a beautiful amphitheater in the Sierra Madre mountains.

The ranch contains more than 120,000 trees. There are 1,200 acres under cultivation, covering an area whose greatest length is three miles and whose breadth is two and one-half miles. Each acre contains 110 trees, and it is estimated will produce 2,000 gallons of olives yearly for the next 20 years. This amount will make 250 gallons of oil, which, at $2 per gallon, will make the revenue $500 per acre. There are forty miles of roads within the ranch. Two hundred and ten thousand dollars has been invested in the orchard and $15,000 in the factory. The average yearly crop is valued at from $250,000 to $300,000.

TEN TIMES LARGER THAN SPAIN'S GREATEST.

Although the olive tree has been cultivated for more than 4,000 years, and olives have formed a staple food of some of the oldest races on earth, yet the young orchard at Sylmar is ten times as large as the largest olive orchard in Spain or the Holy Land.

One hundred and fifty men are employed in gathering the olives in harvest time, which is throughout the months of November, December, January, and on into February. The olive berries frequently weigh down the branches until they touch the ground. Two hundred pounds is a good average day's pick, at an average wage of about $3.00 per day.

The Sylmar ranch was planted about 1894, and the trees yield about 50 pounds of olives each. An olive tree does not come into bearing until it is four or five years of age. As the trees are supposed to live 4,000 years, indeed, some of the trees on the Mount of Olives, in the Holy Land, are known to be over 3,000 years old—an olive orchard may be reckoned on permanently.

BILLOWY EXPANSE OF SILVER GRAY.

The big olive orchard at Sylmar presents a vision of surpassing loveliness. As far as the eye can reach it is one sweeping, billowy expanse of silver gray. The olive trees themselves are not unlike willows in their graceful, somewhat drooping, silhouette. The trees are arranged in orderly rows, and near at hand one sees the peculiarly beautiful shade known as olive green, which becomes a silver gray whenever a breath of wind discloses the under side of the leaf. In the distance the perspective reduces the size and assembles the trees, producing an effect much like a waving field of grain.

The earth on the surface is always carefully pulverized, and, consequently, the water has been drawn up by capillary attraction. There is a strong underground seepage from the surrounding hills.

MAMMOTH SICILIAN OLIVE TREES.

In Sicily, olive trees have been known to attain enormous size, one having grown to the dimensions of 26 feet in circumference, with an expanse at the top of fully 150 feet.

Italy produces, annually, 70,000,000 gallons of olive oil; Spain, 23,000,000, and the United States, about 7,000,000.

The olive berry always grows on new wood, and, in order to increase the yield, the tree is "cut back" and new wood springs out, which bears fruit the second year. It is said that the roots of the olive tree extend as far into the earth as the branches rise above the soil.

GATHERING THE CROP.

The olives are carefully gathered in canvas buckets made for this purpose, and are brought to the factory in spring wagons, to keep them from bruising. The berries are gathered when ripe, although "ripe" olives are frequently "green" in color. After they reach the factory the olives are graded into "ones," "twos," or "threes," according to size. They are then put into a solution of one pound of lye to ten gallons of water. This takes out the bitterness. Here they remain a week to ten days. Then the lye is soaked out by fresh running water, and if they are for table use they are put into a solution of brine, where they remain permanently until bottled up or shipped away.

The olives to be used for oil are gathered from the tree a good deal riper than those used for the table. The oil is extracted by a series of "crushers" and hydraulic presses, which are composed of materials that will not absorb odors, stone and metal being used as much as is possible.

CRUSHING AND PRESSING.

In Italy the olive fruit is crushed and pressed by a simple process. A platform of strong masonry is made about 40 inches high and ten feet long, the surface of the top being slightly hollowed. At the center a strong, vertical, wooden axis is erected, to which is affixed, at right angles to the platform, a millstone about 12 inches broad and weighing about 1,600 pounds. By means of a shaft and yoke beam, a donkey, or ox, slowly moves the stone around. The olives are emptied into the mill trough and crushed to pulp, one attendant constantly turning the mass over with a shovel. In half an hour about 200 pounds can be thus crushed. The thick pulp is then put into soft flat rush baskets, each having only a small aperture in the top, and these are arranged in the press in layers, one above another, up to 15, mouth upwards. Wooden boards are then laid across, and then comes the strong cross beam of the press. To this is attached a strong wooden screw, worked by a lever in the hands of six or eight men, first slowly, then faster, and finally screwed home. The oil flows readily, and runs through a shoot into a hogshead below, filled up to four-fifths of its capacity with water, so that as the oil runs in, the heavy impurities may be deposited and the soluble matter taken up by the water, leaving the oil to collect on the surface. The pulp is thus passed through the mill, two, three or four times, and the final residue, amounting to about 70 per cent of the original fruit, is mostly sold to the large oil works, where it is worked over again. Formerly, it was disposed of to the bakers for heating their ovens.

THE DAIRY INDUSTRY

Butter and cheese have, of course, been produced in the United States ever since we were a nation, but the great manufacturing activities in these lines in modern times, where the actual manufacture of butter and cheese has passed from farms to factories, is a development of the last 50 years; making condensed milk, which is now a very important industry, has also been developed within the same period. The amount of butter produced on farms is far in excess of the amount produced in creameries; it is the reverse with cheese, the far larger part of the total amount of cheese produced in the United States being a factory product; condensed milk has always been made in factories.

AMOUNT PRODUCED.

According to the last census, there were 8,479 establishments engaged in manufacturing milk products. The value of their output was $274,557,718. As this amount was more than double the value of the product in 1900, it is evident that this industry is keeping pace with advancing industry in general. The following figures show the immense amount of dairy products in the last census year, which, no doubt, has steadily increased since.

Butter	624,764,053 pounds
Cheese	311,126,317 pounds
Condensed milk....	494,796,544 pounds

Wisconsin is far in the lead of states in which dairy products are produced in factories; New York is second, with Iowa third.

The first factories for the manufacture of cheese and also of butter were co-operative affairs, but in process of time the tendency is for the factories to pass under individual ownership. Cheese factories had been known in Europe for some time. Creameries are an American institution, the first one being established shortly after 1870. The invention of the Centrifugal Cream Separator introduced in 1879 has made a great change in the creamery business. Condensed milk is also an American invention, being first perfected in 1856. Now, this branch of the industry is very large, not only in this country, but in Europe. One rather surprising fact in regard to condensed milk is that the principal item of cost in its manufacture is not milk, but sugar.

THE FRUIT INDUSTRY

The fruit industry in its commercial aspects is a development of recent times and is growing with great rapidity. There is scarcely an important fruit raised, the production of which has not been doubled, in some cases triples, since the preceding census year. Somewhere within the borders of the United States we raise all important fruits grown. Tropical fruits in Florida, sub-tropical fruits in California, small fruits almost generally throughout our country. The apples from our western states are known all over the world, large quantities being exported.

SMALL FRUITS AND ORCHARD FRUITS.

According to the last census, we raised 426,565,863 quarts of small fruits, such as strawberries, raspberries, cranberries, etc. Raising strawberries for the northern markets is one of the great industries of the South, and when the harvest is gathered, solid trains of refrigerator cars, loaded with this fruit, travel at express speed from Tennessee and Georgia to northern cities. Of orchard fruits, such as apples, peaches, pears, cherries, etc., we raise 214,683,695 bushels. Immense quantities of apples are exported to Europe. We have not given this modest fruit the credit it deserves. In many respects it is the most valuable or-

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IRRIGATING A CALIFORNIA ORANGE GROVE.

chard product we have. When we consider the fruit figures, we understand why it is that the United States puts up over one hundred and twenty-five million cans of fruit every year. The total value of all our orchard crops in the census year was $140, 867,347.

GRAPES.

Grapes are grown almost everywhere. It may not be known that there are vineyards in California with an area of two thousand acres. The last census showed a production of 2,571,065,205 pounds. In view of these figures, it is not surprising that we produced in the last census year nearly four hundred million pounds of raisins and dried grapes, besides nearly twenty million gallons of wine. The value of the grapes grown was $22,027,961.

OTHER FRUITS.

Commercial orange growing in Florida has been rapidly developed since the close of the Civil War; in California since the year 1872. In the last census year we produced from these sources 19,487,482 boxes of oranges, 2,770,313 boxes of lemons and finished the citrus harvest with 1,189,250 baskets of grape-fruit. We have described the immense olive orchards of California; we omitted mentioning that something like sixteen and a half million pounds of olives were produced. The fig orchards of California are evidently very extensive, for over thirty-five million pounds of figs were harvested from them in the last census year. In the production of pineapples and bananas, Florida comes to the front with over ten thousand bunches of bananas and 778,651 crates of pineapples. However, these fruit belong more particularly to the tropics, and it is doubtful if even Florida can compete with Central America in their production. The importation of bananas from that section is simply phenomenal. The opening of the Panama Canal, insuring cheap transportation east, should result in expansion of the California fruit industry.

NEW VARIETIES.

Taking a general survey, the fruit industry in the United States has by no means reached its limits, though the total value of all the fruit raised in the census year was $24,707,000, which is three times the amount raised in 1900. Our population is not only increasing, but we are learning to eat more fruit. There is no doubt this industry will expand in keeping with our industries generally. In this connection, as we have already shown, new and improved varieties of fruit are being produced by a proper application of eugenics to fruit raising.

THE NUT INDUSTRY

The nut industry is not beneath the fostering care of the Department of Agriculture, the efforts being to produce and cultivate improved varieties of nut-bearing trees. The census showed that we produced in the United States 62,328,010 pounds of nuts valued at $4,447,674; 6,733,539 pounds of almonds were grown in California and the Southwest. New varieties have been introduced from Europe. We also raised 9,890,765 pounds of pecans. These are mainly grown in Texas. English walnuts are raised in large numbers in California, 22,026,524 pounds being reported in the census. This tree has been the subject of almost interesting series of experiments by Luther Burbank, a man who is as remarkable in his field of research as is Edison in electricity. His hybrid English walnut is regarded as one of his most extraordinary accomplishments. By a process of judicious selection, he produced trees that grow a profusion of fine, large walnuts, but the shells were so thin that birds could peck into them, so he had to reverse the development and breed back to a tree that put a little more work in on the shell.

COCOANUTS.

Considering that a good many million cocoanuts are used every year in the confectionery trade, we can see that raising them for the market where conditions of growth are favorable would be a very profitable business. But Florida is about the only section in the United States where the conditions are favorable, since the cocoanut tree does not flourish away from the seacoast, and it requires a tropical climate. In the census year over 17,000 cocoanuts were reported from Florida. Probably this industry could be very much increased. From the meat of the cocoanut is compressed a valuable oil, and the dried meat is used for many purposes.

PEANUTS.

It is true the peanut is not a nut, but common knowledge so regards it, and it is raised in such quantities that it is entitled to mention. The census reported a production of 19,415,816 bushels of this unassuming tuber, which has enough real merit to increase its production in keeping with our other great crops, having increased more than sixty per cent since 1900. Its popularity is in no way on the wane and the country fairs, circuses and holiday seasons of decades hence will have an ample supply of this truly democratic nut to supply their demands. This harvest was raised on 869.887 acres and valued at $18,272,000.

To give completeness to this review, it may be stated that all other nuts given in the census year, including walnuts, butternuts, hickory nuts, etc., was 23,617,178 pounds.

SIZE OF FARMS

The average farm the last census year was 138.1 acres. The following comparison of the last two census figures shows how the size of the farms has decreased, but everything connected with it has increased in value.

	1850	1918
Average size of farms......	202.2	138.1
Average value of farm property	$2.738	$6.444
Average value of farm land	2.258	5.471
Average value of farm implements	$105	$199
Average value of farm stock.	376	774

The farms worked by their owners in 1918 were 3,948,722, while 2,354,676 were worked by tenants. The increasing number of tenant farmers from one census to another show that real property tends to concentrate in the hands of the well-to-do, who arrange to have others work their land.

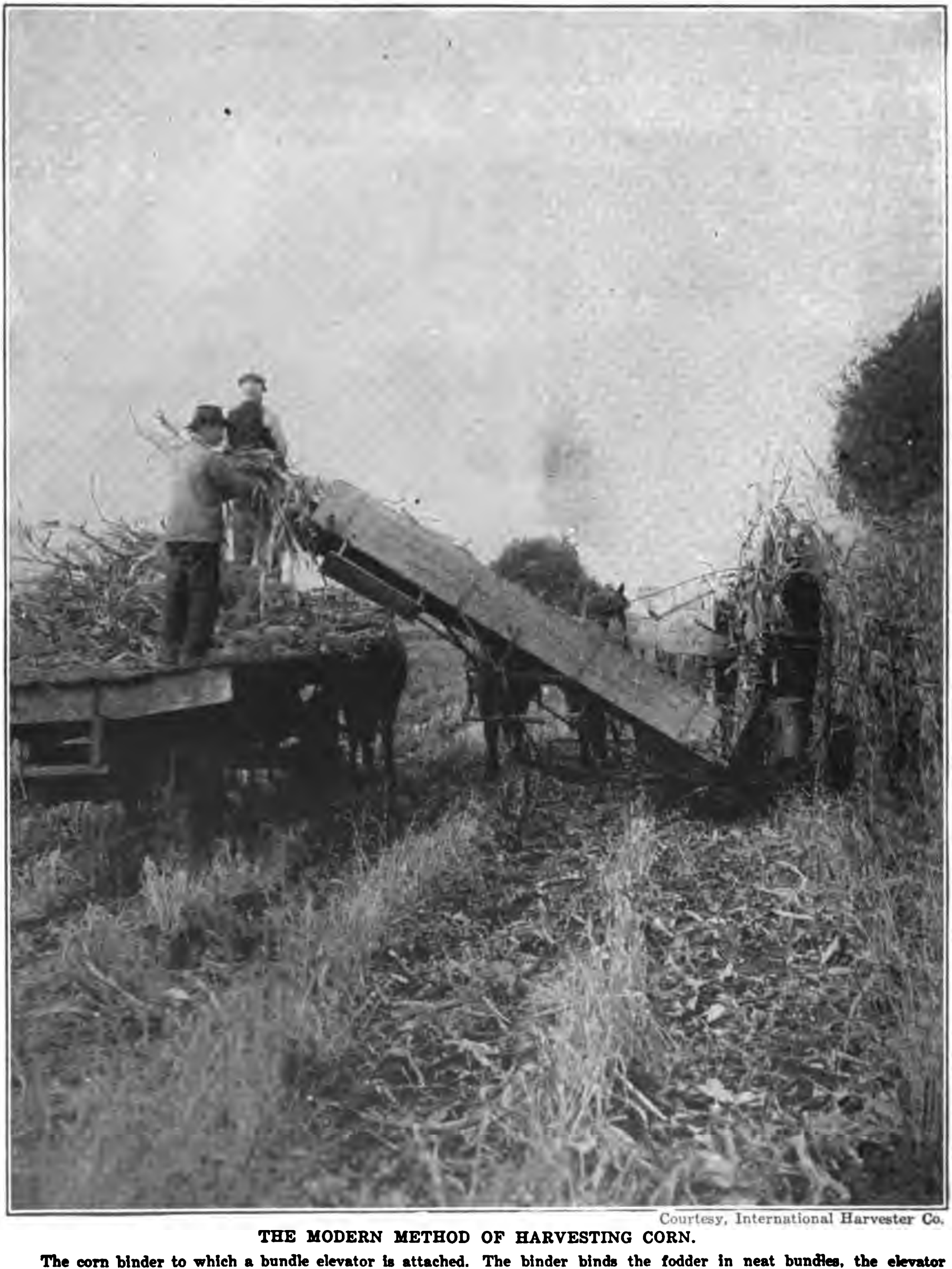
Further examination of the figures for the size of farms show that in the older settled portions of the United States farms tend to become small in size, showing increasing population and more intense cultivation of the lands. The largest average-sized farms are in Nevada, 1,007.6; Wyoming second, 777.6; Montana third, 516.7. In Massachusetts the average size is only 77.9 acres.

THE LARGEST FARM.

The largest cultivated farm in the world, under one general management, where intensive, close, systematic cultivation is the rule, is the Miller farm on the northern boundary of Oklahoma, though there were cattle ranches much larger. One, indeed, in the Panhandle of Texas contained 3,000,000 acres and was larger than the state of Connecticut, truly a large area to be under the control of a corporation. Inclosed within the wire fence of the Miller farm were 50,000 acres. The farm was a striking object lesson in modern, scientific farming, and was run on as correct business principles as an up-to-date factory. It cost about $100,000 a year to run it; of that amount, nearly $25,000 was paid to the Ponca and Otoe Indian tribes as rental for the ground. In the course of the year 300 men were employed in plowing, sowing, cultivating and harvesting the 500,000 bushels of grain annually shipped to market. There were about two dozen head farmers, a number of expert machinists, harnessmakers and blacksmiths. Attending to the business end of the farm was a general manager, a treasurer and financial man, bookkeepers, stenographers and clerks.

GREAT FARMS OF THE WEST.

Every acre produced at least one crop a year; the alfalfa fields yielded three crops; 10,000 acres were sown to wheat each year; about 3,000 planted to corn; sorghum requires 2,000 more; oats, barley, kaffir corn, millet and cowpeas were given about 1,000 more. Two hundred extra men were required at harvest time, but in winter 50 were enough to look after the 8,000 head of cattle in the corral, fix fences, repair windmills and make general improvements. There was $50,000 invested in farm implements.



Courtesy, International Harvester Co.

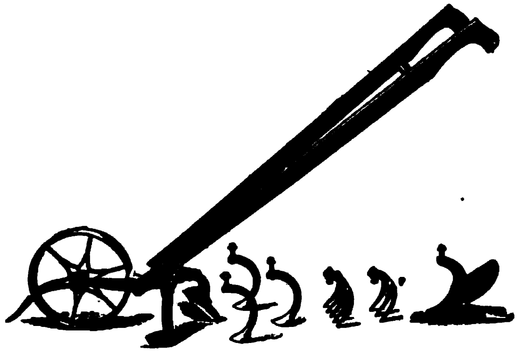
THE MODERN METHOD OF HARVESTING CORN.

The corn binder to which a bundle elevator is attached. The binder binds the fodder in neat bundles, the elevator deposits them on the wagon; this does away with the hard, heavy pitching. These bundles can be put in a silo or shocked. Corn is our most important crop. Any machine that enables us to handle more efficiently is sure of a welcome.

MODERN METHODS IN GARDENING AND TRUCKING

ESSENTIALS IN GARDENING.

Any fertile, well-drained soil, suitable for corn, will produce good garden crops. With a home garden a first requisite is convenience to the kitchen, hence, there is usually little choice as regards special soils. Certain soils have their specific adaptation to special crops, however, and the grower who devotes attention to particular kinds should make a close study of this local factor. In general, "quick," sandy soils are best adapted for early crops. On the other hand, they do not retain moisture so well in the heat of the summer, hence, for later crops a more retentive soil is preferable. Aside from this, on a rolling soil a variation in elevation will often produce crops which mature several days earlier, and even on a small plot this variation should be noted and used to best advantage.



TYPICAL SINGLE-WHEEL HOE AND CULTIVATOR.

PLANNING THE GARDEN.

It is a lamentable but indisputable fact that the farmer's table is not supplied with its daily quota of fresh vegetables as it should be. Poor planning and improper arrangement of the vegetable garden are no doubt in large measure responsible for this. As commonly laid out, the garden requires an endless amount of hand labor, which is always expensive and far in excess of that required for any other proportionate area on the farm. The work should be so planned that the "horse hoe" may be used whenever possible. To facilitate this, the garden should be oblong in shape and the crops planted in long rows. At each end it is well to leave a strip of sod as a turning ground. Group crops according to their season of maturing, placing all perennial crops, such as rhubarb and asparagus, in adjoining rows, and early crops, such as peas and beans, together. The prevailing system of growing the various crops in raised beds is a poor one, except for a few of the very early crops. With these it has an advantage in providing a soil which warms up earlier, but for general crops it is expensive and unnecessary. The soil is also more exposed and likely to suffer from drought.

SIZE OF GARDEN.

Regarding the size of the area for the family garden, much, of course, depends upon the size of the family and their fondness for vegetables. Bailey recommends 100 by 150 feet for a family of five. This is based upon the constant use of the ground and a close succession of crops, a plan which is most essential in the limited area of the city man's garden. In the country, however, conditions are different. Land is more plentiful and help is the expensive item. In this case, less intensive succession of crops, less hand labor, and a larger area of land seem advisable. For the needs of the average farmer's family of five, including potatoes and vine crops, from one-half to three-fourths of an acre is none too large. Essential requirements in the family garden are variety and a regular supply, rather than a large crop of any given kind.

In the garden a limited rotation of crops is essential. Certain crops have their specific enemies, such as the club root of cabbage, and rotation is the only practical method of keeping these foes in check, as well as aiding in maintaining soil fertility.

SEEDS AND TOOLS.

Seed should be purchased from a reliable seedsman and one should expect to pay a good price for a good article. Cheap seeds and bargain packages are invariably a dear investment at any price. Among the most important of the implements for general cultivating and garden work may be mentioned the various types of horse hoes, hand cultivators, and wheel hoes. These types of tools are invaluable and in a single season will pay for themselves in labor saved. They should be regarded as an essential part of one's equipment. In dry seasons thorough preparation of the seed-bed is of special importance. If the soil is cloddy and open it dries out quickly, and poor germination results. The soil particles should be fine and well worked together.

TRANSPLANTING.

In transplanting, it is best to do the work in the cool part of the day, as this enables the plants to revive during the night. Wilting is much less severe in a moist atmosphere, hence when possible it is an advantage to transplant cabbage and other seed-bed crops just before a rain. Wilting is caused by the uncompensated giving off of moisture from the leaves. In the plant there is normally an equilibrium between the root system and the foliage. In transplanting, the root system is partially destroyed and as a result the amount of moisture required for the foliage is in excess of the supply and wilting follows. Hence, in transplanting crops of any kind it is important to cut back the tops to make them balance with the root system. With such plants as celery and cabbage, about one-half of the leaf surface should be cut back. On a small scale, good results may be accomplished by placing a flower pot over each plant for the first day or two. This keeps the plant cool and moist and enables it to become reestablished before being exposed to the hot sun. If the soil is dry, watering after transplanting is advisable, though under average conditions for work done in the spring of the year this is unnecessary. There is an ample water supply in the soil which will be rendered available if pains are taken to firm the soil well, bringing the moist particles into close contact with the delicate roots.

TYPICAL DOUBLE-WHEEL HOE AND CULTIVATOR, FOR STRADDLING THE ROWS.

HARDENING OFF.

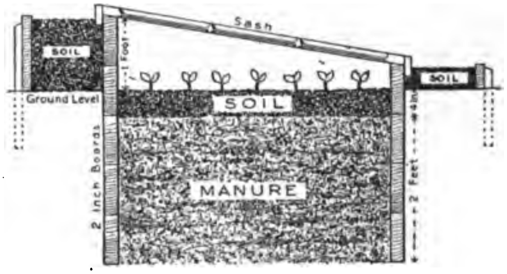
Sudden changes in temperature are always trying on plant life. Plants which have been started within doors should be gradually accustomed to the outside temperature before being placed in the field. This process is known as "hardening off." In hardening off, the plants are usually watered less freely to harden up the growth somewhat, and the ventilation period is gradually lengthened each day until the plants are accustomed to the outside temperature. As a result, such plants readily become reëstablished in the new soil, whereas, if suddenly withdrawn from the higher temperature the check in growth would be severe and earliness often would be sacrificed. This is of special importance, as earliness is the essential object in starting any plants indoors.

HOTBEDS.

For the starting of tomato plants, early cabbage, sweet potato, and similar vegetables, hotbeds are a necessity. The beds should be located upon a south or east slope with a building or fence to protect from the north and west winds. The soil for the frames is usually excavated to a depth of about two feet and filled in with manure. This should be piled and allowed to heat for a few days, and turned before being placed in the beds. It should be thoroughly tramped as thrown into the beds, taking special pains to firm around the edges. The temperature will again rise, and no planting should be done until the temperature has reached its maximum and has fallen to about 90 degrees. Four inches of mellow garden loam should now be placed over the manure, and the bed is ready for use. The seeds may be sown directly in this soil. Care must be taken, especially for the first few days, to provide proper ventilation, as the heat is quite strong and ammonia is given off freely. In the prairie region the sash are apt to be blown off and broken by the wind. To avoid this the frames should be slightly wider than the length of the sash, and an inch strip placed along each side, extending up the height of the sash bar, to prevent the wind from getting under the sash. The accompanying illustration will indicate the general plan and structure of a simple hotbed.

FORCING BOXES.

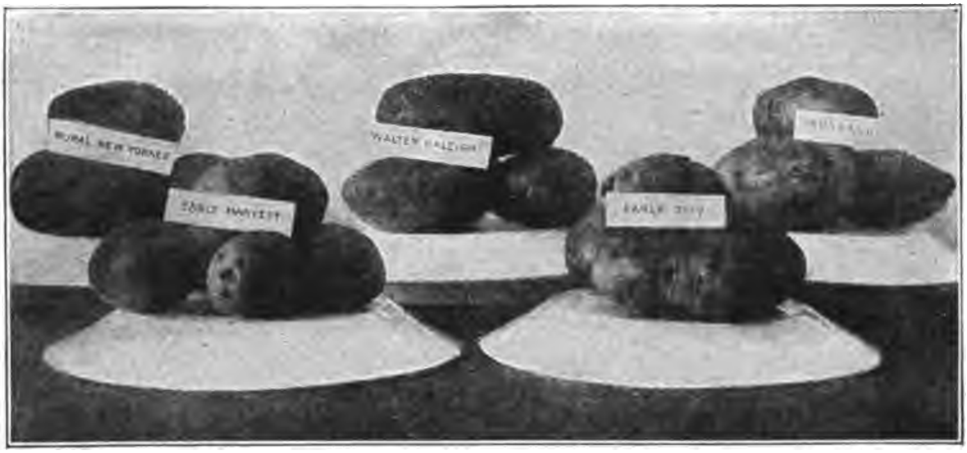
A forcing box is very cheap in construction, and will enable one to secure crops of lettuce and radishes two or three weeks earlier than from out-of-doors. These boxes are operated upon the principle that heat is readily stored up under glass. The soil is spaded and a bottomless box, the size of a window sash, is placed over the area. The sash should be left closed for several days, during which period the temperature will run up considerably if the weather be sunny. The seed should then be sown, and as soon as the plants germinate ventilation and watering will be necessary. If a number of sash are desired, 6-inch fencing boards may be used for the sides.



A SIMPLE HOTBED.

IRISH POTATOES.

The Irish potato is a staple article of food throughout the civilized world, and probably ranks second only to wheat as a food product. It is essentially a northern crop, but thrives best in a warm soil of a slightly sandy texture. The pine lands of this quality in Wisconsin and Minnesota seem to furnish ideal conditions for its growth. The most important point is an ample supply of moisture. Without this, good tubers can not be produced. It is not a bog plant, however, and good drainage is necessary. An ample water supply throughout the season may be secured by early planting and frequent surface tillage. The soil should be fertile, and it is a good plan to plow under a coat of manure in the fall of the year, leaving the ground in the rough until spring. The manure should be thoroughly decayed, however, as fresh manure seems to favor scabby potatoes.



SOME NOTEWORTHY VARIETIES OF IRISH POTATO.

It is often best, as a matter of fact, to apply a heavy coat of manure to some crop grown the previous season, rather than the year the potatoes are grown. In addition to the scab, grubworms are also very much worse in freshly manured soil. The preparation of the ground should be deep and thorough, as the tubers develop better in a loose soil. If plowed in the fall, the ground should be replowed just before planting and the rows then laid out, making the furrow at least four inches deep. With this thorough preparation before planting, the tubers have ample room to form below the surface and they are much less liable to grow above the soil and turn green.

PLANTING.

Seed potatoes should be cut with at least one sound eye to each piece. Cutting machines are used, and for large planting are convenient, but no mechanical device can equal a knife in the hands of an intelligent operator. There is much speculation as to the proper size of pieces and number of eyes to a seed. It should be borne in mind that the eye is a young plant and the tuber contains a storehouse of material for it to feed upon until it becomes established in the soil; hence, the important thing is to have an ample supply of food for each eye. Medium-sized tubers are preferable, and a liberal-sized piece should be allowed to each eye. The use of peelings and small, inferior potatoes for seed purposes is to be condemned, as poor crop and the "running out of the variety" is an inevitable result. Plant 15 inches apart, with 3½ feet between the rows. At this distance ten bushels of seed will be required per acre.

After planting, the ground should be harrowed, in order to make it firm and smooth and to kill young weeds, and the operation should be repeated frequently until the plants appear. Until the young plants have attained a height of four to six inches they may be cultivated with a light, slant-toothed harrow or weeder. This is a very effective method of cultivating, as it destroys the weeds in the hills, where they are difficult to get at with a plow, and it will not harm the potatoes. After this plowing alone can be practiced. This should be continued until the plants have attained full growth and the vines begin to spread, after which no cultivation is necessary except in very dry seasons. The cultivating should be shallow, and many prefer the one-horse cultivator to the double-shovel plow. The last cultivating is done with a double shovel, throwing the furrow to the row, thus ridging the ground slightly.

HARVESTING AND STORING.

The maturing of the tubers is indicated by the dying of the vines. With early varieties and a good market, it will pay to dig at once. Later varieties handle better if left in the ground until well ripened. If the soil is moderately dry it furnishes an ideal place for the maturing of the tubers. In wet falls, however, they will rot instead of ripening if left in the ground after the tops die away. Under such conditions it is advisable to harvest as soon as the tops are dead. Hand digging is expensive and practiced only on a small scale. For large areas potato diggers are largely used and are quite satisfactory. A dark, well-ventilated cellar with a temperature 6 degrees to 8 degrees above freezing is the best place for storing. Raised floors and an interval of a few inches between the bins and the wall should be provided to admit of proper ventilation. It is also an advantage to have the sides of the bins constructed of slats rather than solid boards. The exclusion of light is important, as the tubers develop chlorophyll and turn green in the presence of sunlight, which spoils the flavor of the tuber. Temporary storage may be provided in the fall by piling and covering with straw to protect from frost. Sprouting in winter usually indicates too high a temperature, and may largely be prevented by keeping the temperature down and excluding the light.

Varieties vary much in their adaptation to local conditions. Those grown on wet, swampy soils are watery and more or less tough in texture. The same varieties grown on upland soil will be higher in flavor and more mealy in character. Restaurant and hotel-keepers prefer the former for Saratoga chips and the latter for baking. *Early Ohio, Maggie Murphy, Carman,* and *Rural New Yorker* are standards. The *Burbank* is another favorite variety and regarded by many as of the first rank in quality, though not so productive as the others named.

SWEET POTATOES.

The sweet potato is distinctly tropical in its requirements. A light, warm soil, rich in organic matter, is essential. Cold or heavy clay soils are unsuccessful. In the South, level culture is practiced. In the cooler sections of the North the ridge system secures a warmer soil, and is an advantage, especially in wet seasons.

PROPAGATION AND CULTURE.

The sweet potato is usually propagated from shoots started in hotbeds. The tubers are placed quite close together but not touching each other, and covered with 2 or 3 inches of soil. The shoots are taken off when 3 or 4 inches in height, and transplanted to the field when the ground becomes warm. Frequent cultivation of the surface soil is important and will do much toward producing good-sized tubers. The question is often asked as to whether or not it will pay to remove the vines in order to prevent their rooting. A number of experiments have been conducted along this line, and the consensus of opinion is that it will not, there being little difference in yield between the crops so treated and those where the vines have been allowed to grow unmolested.

The sweet potato is a main-season crop and the vines remain green until frost. Before digging, the vines should be mown off with a brier scythe. If the crop is caught by an unexpected heavy frost the vines should be cut away in the early morning before the sun blackens them, otherwise the keeping qualities of the roots seem to be affected. The tubers bruise readily, and require careful handling. They must have a higher storage temperature than that of other root crops, keeping well in a temperature of 55 degrees to 60 degrees. The roots are usually packed in barrels, buckwheat chaff or sawdust being used as a filler.

In popular parlance the term "Yam" is used to designate the yellow-skinned types of sweet potato. In the South this type reaches perfection and produces tubers with a high percentage of sugar and of a rich, mealy character. In many parts of the North, however, the red sorts are preferred. Vineless varieties of the sweet potato have attracted recent attention. Such a type is no doubt desirable, but the varieties produced thus far have generally proved poor bearers. *Florida, Red Jersey,* and *Yellow Jersey* are among the most productive sorts in the North.

ONION CULTURE.

A convenient plan is to sow with a drill, placing the rows 12 to 15 inches apart. When the plants reach a height of three inches, thin to four inches apart. In doing this care should be taken that the remaining plants are left intact, with the soil firm around them. Careful handweeding is necessary until the plants become well established. If neglected in the early stages of growth, the young plants are easily smothered out by weeds. This is the most expensive period in the growing of onions.

When the tops die off the crop is ready for harvesting. Bunch three rows together and allow them to lie until perfectly dry. This period is a critical one in the care of the crop. If allowed to remain in the ground after the tops die they are likely to throw out new roots after the first rain. On the other hand, the bulbs must be thoroughly dry before storing. A cool, dry shed should be provided for this purpose. A series of shelves, four inches in depth and with ample space between for free circulation of air, furnishes excellent conditions for storage. Freezing is not injurious, if the building is well enclosed to prevent sudden freezing and thawing. For small crops a portion of the haymow may be used for storage.

ONION SETS.

Sets are produced by sowing the seed very thickly and preferably on a poor soil. On account of the crowded condition the young bulbs can not develop fully and growth is arrested when they are about half size. To prevent the sets from overgrowing the seed should not be sown until the middle of June. Bulbs one-half inch in diameter command the top price. The sets are planted as soon as the soil can be worked in the spring, and the crop is usually ready for market by the first of June. The bulbs are set three inches apart and about three inches deep, taking pains to firm the soil well around the bulb. There are three general types of varieties, white, red, and yellow skinned. The white are usually more mild in flavor. In many markets the demand for red exceeds all others. *Early Red Wethersfield, Yellow Strasburg,* and *Silver Skin* are general favorites.

PEA CULTURE.

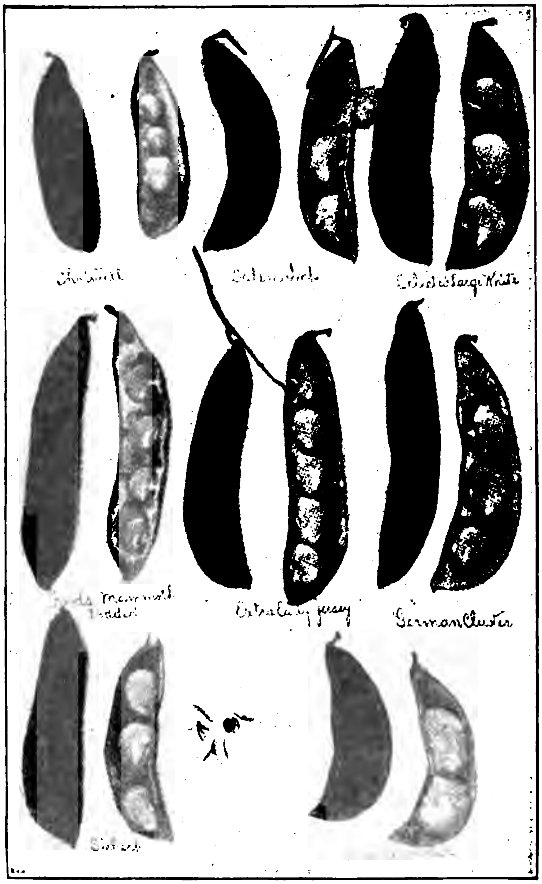
Peas should be sown as soon as the ground can be worked in the spring. In many sections successional crops may be had by planting every two weeks. In the drier atmosphere of the Northwest, however, they do not thrive well in late summer, and the early-season crop is the main one. A fall crop may be secured by sowing early-maturing varieties the forepart of July. A good rotation may be secured by planting the ground to early potatoes, harvesting these in July, and sowing to peas for a fall crop.

There are two types of peas generally grown in the United States, those having a small, *round seed,* and those having *wrinkled seed.* The wrinkled sorts are the less hardy and should be planted later in the spring. While less vigorous than the smooth, round peas, they are regarded by many as superior in quality, and for this reason are preferable for the main-season crop. In addition to these there is a third type with an edible pod, known as the *sugar pea.* While popular abroad, they are little grown as yet in this country.

The tall-growing varieties of peas are usually grown in double rows 5 feet apart and supported by brush or wire netting. The dwarf sorts are equally productive, however, and are largely supplanting the tall kinds, because they require no support. On rich soil peas tend to vine too heavily, and the best crops are secured on a moderately poor soil.

BEAN CULTURE.

The garden beans are natives of the warmer parts of South Africa, and are very tender to frost. For this reason they should not be planted until the ground has become warmed. A good guide for planting time is "when the oak leaves reach the size of squirrels' ears." If the seed is sown too early it decays quite readily.



SOME STANDARD VARIETIES OF LIMA BEANS.

In their cultural requirements beans are divided into two types: *Pole Beans*—climbing varieties which require a support—and the dwarf, compact-growing sorts, known as *Bush Beans.*

The climbing Lima bean belongs to this type and is a kind of high flavor, much prized in the South and East. It is more tender than the bush beans, however, and for this reason is not so successful in the Northwest. In that section the Dwarf Limas are more satisfactory. In planting pole beans it is best to place the poles, before planting, in rows three feet each way. If the soil is thin it is a good practice to apply a shovelful of well-decayed manure under each hill. To insure a good stand, six to eight seeds should be sown to each pole. Wire netting is a convenient support and in many sections is preferable to poles. Some of the standard varieties of pole beans are *Dreer's Pole Lima, Siebert's Lima,* and *Large Lima.* Bush beans require a very much shorter growing season, and by successional sowings may be had for table supply throughout the summer. The last planting should be made at least seven or eight weeks before heavy frost. To secure good snap or string beans a rapid growth is necessary. Otherwise the pods become stringy. It is also necessary to keep all pods picked, allowing none to mature, for the ripening seeds will check the growth of the plant and destroy the future supply of green pods. When grown as a field crop for market the plants are pulled by hand and piled with the roots upward, or harvested with a bean puller. If not allowed to stand until the pods shell too much they may be mowed and raked up as hay. For small quantities, a hand flail and fanning mill may be used for threshing and cleaning. By large growers, a regular bean thresher is employed.

VINE CROPS.

Vine crops are frost-tender and thrive best on a warm, sandy soil. They are grown in hills and cultivated both ways so long as the vines will permit. In the North they require the entire season for growth and should be planted as soon as the weather becomes well settled and warm. The flowers of vine crops are monecious, that is, the male flower is borne upon one branch and the female upon another. The pollen is transferred by bees, hence this insect plays an important part in the growing of this class of vegetables, failure being sometimes due to lack of proper pollenization. Plant cucumbers as soon as the soil becomes thoroughly warm, in hills six feet each way. To allow for insect ravages it is well to plant six to ten seeds to a hill, and thin to three when the plants begin to vine well. Cultivate both ways as long as possible. No fruit should be allowed to ripen on the vine, as this will cause the plants to discontinue growth and cut short the crop.

POPULAR VARIETIES OF CUCUMBER.

MUSKMELONS.

There is much confusion regarding the use of the term muskmelon and cantaloup. With some the terms are regarded as synonymous.

According to Bailey's *Cyclopedia of American Horticulture* the cantaloup is a special form of muskmelon, having a deeper furrow and a hard rind. The culture of the muskmelon is similar to that of the cucumber. The fruits are of a higher flavor if allowed to remain on the vines until they separate readily at the shoulder. A large, nearly smooth-skinned type known as the *Montreal* muskmelon has recently arosed considerable interest in the West. While of a superior size it is coarse and low in quality. In fact, as a class, the medium-to-small-sized varieties with a finely netted skin are the best quality. Of this type the *Netted Gem* and the well-known *Rocky Ford,* which is a slight variation of the Gem, are good examples.

AN EXCELLENT VARIETY OF MUSKMELON, OF THE FINE-NETTED SKIN TYPE.

WATERMELONS.

The watermelon thrives best in the South. Good crops may be grown in the North, however, if planted on an early "quick" soil. The hills are usually placed eight or ten feet apart, and if the soil is thin, a shovelful of well-decayed manure should be placed under each hill. The fruit is borne on the side branches, and many growers recommend the pinching back of the terminal buds to stimulate side growth.

The citron is a fruit very similar to the watermelon in appearance and culture, but bearing a thick, hard, fleshy rind, which is used for preserving.

PUMPKINS.

Pumpkins are coarse growers and, hence, are generally planted in the field rather than the garden. A favorite plan is to plant in alternate rows in every second hill in the cornfield. The fruit should be stored or covered with fodder upon the approach of heavy frost. The crop is largely grown for stock, and finds only limited use as a table vegetable.

SQUASHES.

The term "squash" is quite a broad one, including those classes of gourds which produce an edible fruit. It is a popular error that squashes, pumpkins, and melons will cross-fertilize if planted near one another. Those who have made careful investigation, however, are emphatic in their statements that such is not the case, and that squashes never cross with watermelons and spoil their flavor, as is sometimes stated. Hand crosses between the pumpkins and squashes failed in the majority of cases, and in no case were the results apparent until the second generation.

The general cultural requirements of the squash are similar to those of the cucumber except with the long-vined sorts, for which the hills should be ten feet apart. Sow six to eight seeds per hill and thin to three. Of the summer squashes, *Silver Custard* and *Crookneck* are good varieties; of the winter squashes, *Boston Marrow* and *Hubbard.* There are two distinct types of squashes—the summer and winter species. The summer varieties mature early and are used before the rind hardens. The fall and winter varieties are usually provided with a hard, flinty shell of a warty appearance. The Hubbard is a well-known and excellent representative of this class. Winter varieties are readily stored if handled carefully and held at a medium temperature.

ANNUAL ROOT CROPS.

Root crops are of the easiest culture. The essential conditions are a deep, rich soil, with ample moisture. A straight, symmetrical root is required, and to secure this, deep plowing and a well-prepared seed-bed are necessary. The soil should be fertile, but it is not advisable to plow under fresh manure, as the roots are apt to acquire an astringent flavor and a forked growth. On poor, clay soils the roots are usually leathery and of inferior quality.

BEETS.

There are two general types of beets—the turnip-rooted and the long-rooted. The turnip-rooted sorts mature the more quickly and are generally grown for the early-season crop. The beet ranks with the onion and pea in point of hardiness, and should be sown as soon as the ground is in a tillable condition. Plant one inch deep in rows three feet apart. As the seed usually germinates unevenly, it is well to sow thickly. Thin as the plants reach five or six inches in height until they are 5 inches apart. The thinnings make excellent greens. By successional sowing a supply may be had throughout the summer and fall. Upon the approach of heavy frost the crop should be pulled and piled. The tops are cut off two inches above the crown. This is important, as, if the crown of the root is cut, they readily decay. Store in a cool cellar or root pit. If the atmosphere is dry they should be covered with slightly moistened soil or sand. If allowed to dry out the roots become wilted and corky. Good corn land is well adapted to beet growing, and for early varieties a quick, sandy soil is advantageous.

CARROTS.

Like other root crops, the carrot thrives best on a rich, deep, well-drained soil. The plants are quite hardy and of the easiest culture when once established. The seed germinates slowly, and hence it is a good practice to sow with it some companion crop, such as radish. This will keep the rows defined and insure early culture. Early culture is important, as the young plants are rather delicate and easily smothered out by weeds if neglected. The seed should be sown rather thickly and the plants thinned to three inches apart. Early varieties are sown as soon as the soil will permit. The winter crop should be sown about the first of June. Crops intended for storing should not be planted before this, as they may mature their growth and the tops will die off while still in the soil. The roots which are harvested while still in a growing condition store best and are of superior quality. For convenience, the first step in gathering carrots should be the mowing off of the tops with a brier scythe or cropping off with a hoe. Digging may be facilitated by plowing a furrow from the row on each side, or plowing out the roots.

TURNIPS.

The turnip is a moisture-loving plant and does not thrive best in the hot, dry atmosphere of midsummer; hence it is grown almost entirely as a spring and fall crop.

The seed is sown early and the roots usually reach marketable size in eight to nine weeks. Turnips are often sown as a successional crop with early potatoes and cabbage. The seed is sown broadcast and the only important point in culture is that the plants have an ample supply of moisture. The soil is likely to be dry when the fall crop is sown; hence, thorough preparation of the seed-bed is necessary. Germination may be assisted by rolling, which brings the moist particles of soil into contact with the seed. Turnips are injured by freezing, and should be stored in a cool cellar before heavy frost. The roots are largely used as stock food and find only a limited demand as a table vegetable. The rutabaga is identical with the turnip in its culture, with the exception that it requires a longer season for growth, and for the winter crop should be sown four or five weeks earlier.

SALSIFY.

This is a delicious winter vegetable of the simplest culture. It is often called "oyster plant," on account of its oyster-like flavor. The plant is as yet comparatively little known in this country, but should be more generally grown.

SANDWICH ISLAND MAMMOTH, THE STANDARD VARIETY OF SALSIFY.

Salsify is a main-season crop and should be sown early in the spring. The roots are not injured by frost and may be left in the ground over winter or stored. They become woody and unfit for use after growth begins the second spring, however. The general culture requirements of salsify are similar to those of carrots and parsnips.

PARSNIPS.

Sow early and give the same culture as for the carrot. The roots may be stored or left in the ground over winter. If stored it is best not to dig them until after heavy frost, as the roots seem to be improved in quality by freezing. The seed is slow in germinating and radishes may be sown with them as in the case of carrots.

RADISHES.

To produce crisp, tender roots the radish requires a cool, moist season of growth, similar to the turnip. Sow early in the spring, and repeat at intervals of ten days for successional crops. Early varieties mature in from twenty to thirty days. Winter varieties with a long, tapering root are grown to a limited extent only. One of the best varieties of this type is the Black Spanish.

PERENNIAL ROOT CROPS.

The crops placed under this heading are not closely related botanically, and are arbitrarily placed in this section on account of their similar cultural requirements and their permanent location in the garden. Their permanency indicates the necessity of thorough preparation before planting. An asparagus bed, for example, should yield profitable crops for twelve to fifteen years, provided the preparatory work has been properly done. In preparing the bed for any of these crops the ground should be deeply plowed and a heavy coat of well-rotted manure worked in. If the soil is not in good mechanical condition it will also be an advantage to plow in the fall and leave the the ground in the rough over winter.

ASPARAGUS.

Asparagus is a hardy perennial, native of Europe, propagated by division of the roots or by seed. If propagated from seed, which is the best method, the plants should be grown in the seed-bed the first year and transplanted to the permanent bed the second spring. As the bed will last for a number of years if the crop is properly planted, thorough preparation is of special importance. The land should be deeply plowed and heavily manured with well-rotted stable manure the fall before planting. As the stalks are the edible portion and asparagus is a strong feeder, it will require annual applications of manure throughout the life of the bed.

The rows should be six feet apart and the plants two feet in the row. A convenient method of planting is to furrow out the rows to a depth of 8 inches, and plant in the bottom of the furrow. Cover the roots lightly at first, packing the soil well, however, around them, and gradually fill in the furrow as the stalks appear above the surface. This is a more convenient system than the old one of planting in solid beds, and will give good results. The plants should become well established before any crops are harvested, and for this reason it is best not to gather any stalks until the second spring after the plants are put out, and even then it should not be cropped heavily the first time. During the first two years frequent tillage is important. After the plants become well established the ground is sufficiently shaded and mulched to give little trouble from weeds.

The shoots should be gathered as they appear in spring and before they are more than eight or ten inches in height. If allowed to grow taller than this they become woody. The stalk should be gathered by reaching two or three inches below the surface, grasping the stalk with the fingers and breaking off with a simple twist. A case-knife is often used for this work, but it is not to be recommended, as the young crowns are clustered together and the blade of the knife is likely to sever a number of them, spoiling the future crop. Cropping should cease about the middle of June and the tops thereafter should be allowed to grow at will. After frost in the fall the tops are mown off and the beds well dressed with rotted manure. Asparagus is a native of the seashore and occasional applications of salt will stimulate growth.

RHUBARB

The most convenient method of propagating this vegetable is by division of roots. The plants may be set out in either spring or fall, planting four feet apart in rows five feet wide, in a rich, moist soil. No crop should be gathered until the second year after transplanting. Give clean culture during the summer and apply a coat of manure in the late fall. This should be plowed under the following spring. This mulch will prevent deep freezing, thus securing an early crop of stalks in the spring, and the additional supply of plant food will also aid in procuring a rapid growth. Rhubarb is essentially a moisture-loving plant and if properly supplied with water and an ample food supply, an excellent growth is insured. There are apparently no new varieties of superior merit. The old standards, the *Linneas* and *Victoria,* are favorites. The Linneas is an early variety and less acid than the Victoria. The Victoria is a strong, heavy-growing sort with pink stalks and a more decided acid flavor.

Rhubarb is readily forced in a warm cellar; hence, winter crops of this delicious vegetable may be enjoyed by digging the roots late in the fall and storing them in a warm, dark cellar. The roots should be dug upon the approach of heavy frost and left above ground for a couple of weeks for the purpose of freezing. This freezing process is necessary, for without it the roots do not take on an active, vigorous growth when brought into a warmer temperature. The roots may be packed in closely, with only sufficient soil attached to supply moisture, and the cellar should be practically dark. Occasional watering may be necessary to keep them moist. The temperature should be medium. This winter forcing is a very simple process and may be employed by any farmer who will comply with these conditions. Well-established roots should be used. Forced roots, of course, are very much weakened, and if again planted out-of-doors will not bear crops until the second year.

HORSE-RADISH.

Horse-radish is a hardy perennial of the simplest culture. A rich, deep soil furnishes the best conditions for the development of symmetrical roots. Propagation is by root cuttings, which should be one-half to three-fourths inch in diameter and four to six inches in length. To insure planting them with the crown end up it is well to make the upper cut sloping. The roots are used as a condiment with meats in late fall and early spring. A winter supply may be had by storing roots in most soil or sand in the cellar. Grated horse-radish soon loses its strength. Freshly grated and neatly bottled packages find a ready sale in small towns, and one can nearly always find an excellent local trade for a limited supply.

CABBAGE.

Cabbage is a hardy, partial-season crop. The plants are usually started in the hotbed or window box and set out when the second or third true leaves appear. An excellent seed-bed for starting the plants may be secured by burning straw or brush to warm the soil and kill weed seeds; then pulverize and sow at once. The early varieties are set out as soon as the state of the ground will permit, and do not suffer seriously even if caught by late frosts, provided the plants have been properly "hardened off." The seed for the fall and winter crop is usually sown about the middle of May. The distance for planting varies much, as some varieties produce very large heads and others small ones. For the general run of varieties, two feet apart in the row is a convenient distance. If the plants are spindling they should be planted deeply and side roots will be emitted along the buried portion of the stem. A rich soil and frequent surface tillage to conserve the moisture and a uniform period of growth are the essential conditions for successful cabbage culture. If the soil becomes dry the heads "set." If rains follow later a second growth comes on, causing the heads to split and making them practically worthless for market.

Upon the approach of heavy frost the plants should be pulled and stored in a pile with the roots up. Cover with three or four inches of straw, and as winter approaches add layers of earth to protect from freezing and thawing. For storing purposes the heads which are not quite solid and mature preserve best. In storing out-of-doors, it is important to secure a site where the drainage is good. Ventilation should be provided by small openings through the sides of the pile. If the supply is to be used during the winter, a more convenient method is to store in a root cellar where the temperature is about thirty-six degrees.

In storing cabbage it is very important that the heads should be well drained. When growing in the field the leaves gather the dew, so that heads for storing should be pulled and piled with the roots upward for several hours to allow the water to drain out of the leaves. A method of storing, convenient for the farmer, is to store the heads in barrels; they will preserve better, also, if each head of cabbage is wrapped up in a newspaper.

CAULIFLOWER.

This is a variety of cabbage which has been improved by the enlargement of the terminal flower buds. Its cultural requirements are similar to those of cabbage. It requires more careful attention, however, and commands a better price on the market. The heads should be shaded for blanching when two-thirds formed. A convenient method of doing this is to break the midrib on the large, outer leaves and pin them together over the head. Kohlrabi is another member of the cabbage family, with an enlarged, turnip-shaped stem, grown considerably as a winter food for stock and in a limited way as a garden vegetable. The tubers should be used when two or three inches in diameter, as they become tough and woody when older. *White Vienna* is one of the best known varieties.

LETTUCE.

For the first crop it is an advantage to sow in raised beds, as such soil warms up earlier. Later crops are sown in rows and thinned to eight inches apart. The last crop is usually cleared by midsummer, and the ground may be used for fall turnips. If the daily supply is gathered early in the morning before becoming wilted by the hot sun it will be the more crisp and palatable. There are two general types of lettuce—head or cos lettuce, and the loose or leafy type. The cos variety forms small cabbage-like heads, and is a type of superior quality. It requires a longer period of growth, however, and greater care in culture. For the farmer's garden the loose type will generally be found preferable.

CELERY.

The growing of celery is largely restricted to the market gardener, for the reason that its cultural demands are more exacting than those of other crops. On the other hand, the value of the crop is greater in proportion. In fact, there is probably no plant grown which will bring as large returns per acre as celery, and in most towns and villages there is an excellent demand for a limited supply. The essential requirements for successful celery growing are a rich, moist soil and early transplanting, that the plants may become established before the hot, dry weather comes on. The grower who is not able to irrigate will find bottom lands most satisfactory. The plants should be started in the seed-bed and transplanted once before being put out. The first transplanting is usually done when the second or third true leaves appear. The crop is usually put out about the middle of June.

There are two general systems of culture for celery—the level culture and the trench system. In the trench system a furrow is laid out, a man following with a spade, to deepen the trench to twelve or fourteen inches. The plants are then set in the bottom of this trench. At blanching time in the fall the trench is merely filled in. The level-culture system is similar to that practiced with other garden vegetables. Both systems of culture have their special points of advantage. In dry seasons the plants in the trench fare better on account of being protected from the dry winds and somewhat shaded. In wet seasons the level culture is very much more successful. This system involves less labor, and on the whole is probably to be preferred. The plants should be set out late in the evening, while it is cool, and it is also well to remove one-third or one-half of the top to prevent wilting. Frequent tillage should be given throughout the summer to insure a constant supply of moisture.

BLANCHING.

Before the stalks can be used for the table the green coloring matter must be removed. This is brought about by any practical method which will exclude the light. For the early, dwarf varieties, twelve-inch boards may be used, set up on each side of the row, with a strip across the top to hold them together. The placing of 4-inch drain tile over each plant is also a simple method. With the later crop, soil is often used for blanching. If soil is used, care must be taken to gather the stalks together before placing it around them. A convenient method is for a man and boy to work together, the lad working on the opposite side of the row, gathering the stalks, and holding them in position until the soil is filled in around them. This can not be completed at one time, and two or three operations are necessary. If the crop is to be stored in the cellar for the winter, outdoor blanching is not necessary. The roots should be taken up for storing upon the approach of heavy frost and placed in a cool cellar, packing a small quantity of soil around the roots to keep them moist. The plants may be packed quite closely together and if the light is excluded, blanching will be completed in three or four weeks. If the soil becomes dry, occasional watering may be necessary. A temperature of fifty to sixty degrees is suitable. The crop may also be stored out-of-doors by covering with straw and layers of soil to protect from frost. This is not convenient for getting out supplies in cold weather, however, and cellar storage is preferable for the small grower.

TOMATOES.

Where there is a choice of location, a warm soil is always preferable for the tomato. In a bad location or in cold, wet seasons plants set fruit poorly, the foliage takes on a yellow complexion, and a poor crop invariably follows. To secure fruit of good color and free from rot, a support of some kind is an advantage. Posts, wire netting, or any framework that will spread the vines and admit sunlight and air will fill the requirements. The yield of the tomato is materially increased by proper training. The relative solidity of fruit is an important factor in determining the shipping and keeping qualities. Fruits of the same size from different varieties vary much in weight, the heavy ones containing small seed chambers and a large proportion of flesh. Varieties showing this character of fruit invariably keep and ship better than the lighter fruited

SPECIMEN TOMATOES OF STANDARD VARIETIES.

sorts. Upon the approach of frost the green fruit may be gathered and stored in a sunny room to ripen.

There is a long list of varieties of tomatoes, many of which are of excellent quality. The ideal type of tomato is a smooth, medium-sized fruit with small seed cavities and a large proportion of flesh. If they are grown for market the medium-sized fruit, evenly graded, is preferable to the large varieties. *Acme, Dwarf Champion,* and *Livingston Beauty* are much grown. The yellow-fruited sorts are more meaty than the reds. The flavor is distinctly peculiar, however, and while preferred by a few who have cultivated a taste for them, they are not in general demand.

EGG PLANT.

The egg plant, like the tomato, should be started within doors. It is even more tender than the former plant, however, and should not be planted out until the weather becomes settled and warm. Well-drained soil is important, and without this or in cool seasons the crop is likely to be a failure. The plants are usually set two feet apart in the row. *Black Pekin* and *New York Improved* are favorite varieties. There are also small scarlet and white varieties, the fruit of which is used for decorative purposes and is of little value as a vegetable.

ONE OF THE FAVORITE SORTS OF EGG PLANT.

PEPPERS.

The plants may be started in the hotbed or sown directly out-of-doors after the weather becomes warm, and thinned to twelve inches apart. A variety collection of peppers shows a most interesting variation in size, shape, and color. The seedsmen's general list of standard varieties is quite successful.

SOME POPULAR VARIETIES OF PEPPERS FOR VARIOUS USES.

SWEET CORN.

For corn as a garden crop, earliness and a succession are matters of prime importance. For the early crop choose a warm soil and plant in hills. For the main-season crop many prefer to plant in rows. Especially for the early varieties, which are planted before the ground has become thoroughly warmed, should one make sure of having fresh, vigorous seed. Germination may be hastened by soaking the seed in warm water over night before sowing. Varieties vary much in the length of their growing period, and are often classed as early, medium, and late. The *Early Cory* and *Early Maine* are excellent varieties for the West, and mature in eight to nine weeks.

Stowell's Evergreen is largely grown for the main-season crop. *Country Gentleman* and *Ne Plus Ultra* are valuable late varieties.

POPCORN.

This crop adds to the enjoyment of the long, winter evenings, and a few rows should find a place in every vegetable garden. Its consumption is increasing, and popcorn is becoming a crop of commercial importance in a few localities. At one point in Northern Iowa a single grower devotes 500 acres to popcorn, and there are many others of less importance. Its general culture is largely the same as that of field corn. As the crop is not salable until a year or more old, good storage room is important.

MAKING AND CARE OF LAWNS.

There is nothing that adds more to the external beauty of a home than a well-kept lawn. A perfect lawn is not obtained by simply seeding with certain kinds of grasses. A green surface may be obtained in this way in a few months under favorable conditions, but a soft, velvety turf that is a delight both to view and to walk upon, is obtained only after the exercise of intelligent care for a period of years.

It must be remembered that the lawn, when once formed, is to remain undisturbed; the sward is to be permanent, and hence the importance of most thorough preparation of the soil. The first essential is thorough underdrainage. Where the process of grading has involved much filling in time should be allowed for settling of the soil. If grading is done with soil removed in excavating the cellar, it should be covered over with four to six inches of good surface soil, as rich as possible in vegetable matter. If the soil is full of weed seed, it should be hoed one season, if possible, to get it cleaned up. Well-rotted manure should be used quite liberally and the surface put into the very finest condition possible, as the seeds to be used are very small and the plants, for a time, very delicate.

SELECTION OF SEED.

For sections of the country to which it is adapted there is no better grass than the Kentucky blue grass. This is made more thrifty in many localities by the volunteer entrance of white clover during favorable seasons. Some of the fescues or timothy may be sown with it as a protection while it is getting a start. The blue grass will crowd them out when it gets a hold. Too great care can not be observed in obtaining pure seed, as foul seed may cause a great amount of annoyance and extra work.

Seed should be sown very early in the spring to get a good start before the weather gets too dry and hot; or in the early fall after the rains and cooler weather have arrived. The seed should be sown evenly and not covered very deep, a light raking with a garden rake being all that is necessary. If there is no immediate prospect of rain, the ground should then be rolled, to press the seeds into close contact with the earth and aid in their germination. If a good growth is not obtained the first season, and especially if the lawn is in an exposed situation in a severe climate, it should be covered the first winter with coarse manure for protection. This manure should be as free from weed seeds as may be. It can be left on in the spring until the grass starts, giving opportunity for some of its finer and more soluble particles to be transferred to the soil by the spring rains, when it should be raked off.

Spring seeding, if followed by dry, hot summers, may also be advantageously protected from the sum in a similar way, using hay or straw for the covering, but only just enough to form a shade.

TRANSPLANTING TURF.

A good turf may be obtained more quickly in this manner than by seeding. The ground that is to receive the turf should be well loosened and made smooth and even on the surface. A piece of smooth, tough sod of the desired grass and free from weeds should be selected from which to obtain the supply. Cut this turf in strips about one foot in width, two or three inches in thickness (great care should be taken to have the thickness uniform), and of such length as will make them of convenient weight to handle. These are rolled up into snug rolls for convenience in handling.

The turf is then transferred to the prepared soil, closely laid, rolled, and watered. This method has the advantage of providing a fine turf the first season and insures a good, clean sod, free from objectionable plants, a result not always readily obtained by seeding. An occasional covering with manure during the winter, as above described, will be found of great benefit in keeping up a healthy, vigorous growth, and in giving a rich, green color to the grass.

MODERN POULTRY RAISING

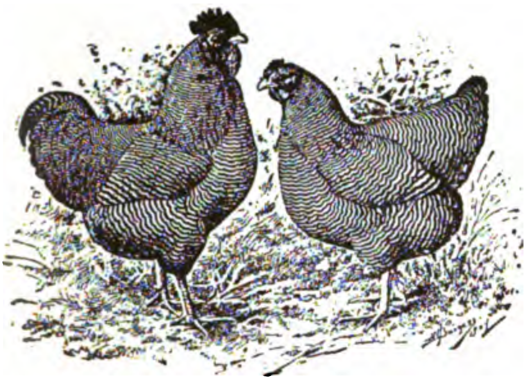
The first step toward a venture in poultry raising is the selection of a breed. On most farms there will be found already flocks of thorough-bred fowls or grades. A flock of well selected barn-yard fowls will prove a satisfactory foundation for a practical venture and if thorough-bred birds are found the condition is better yet.

If the fowls on hand are not thorough-bred a definite plan of procedure should be adopted toward the end of breeding them up to a uniform type. Kill all males and select the best of the females and purchase thorough-bred males of the breed you favor and mate them with the females. In only one season the result will be surprising. The chicks reared the very first year will be uniform in size and the difference in color will be much lessened. By the end of the third season, by using strong, vigorous males of the same breed each season, a breeder can have his flock almost as uniform for all practical purposes as if he had always bred thorough-bred birds.

If no fowls are on hand or if they are of a variety not desired it is necessary to make a decision as to what variety shall be adopted. Within certain limits the buyer should make his own decision. It is assumed that this is a venture in practical poultry raising, although it will be developed later that even in the most practical poultry undertaking there is an added revenue to be obtained from standard bred fowls.

INTEREST IN THE WORK.

The different general purpose varieties vary little as to actual worth and one's fancy may safely be allowed free range among them without practical consideration receiving a set-back. Success with poultry depends so much on personal care that it is worth much to have a flock that really appeals to one's affections, for the care of such a flock will be easy and spontaneous, where under different circumstances it would be tedious work and drudgery.



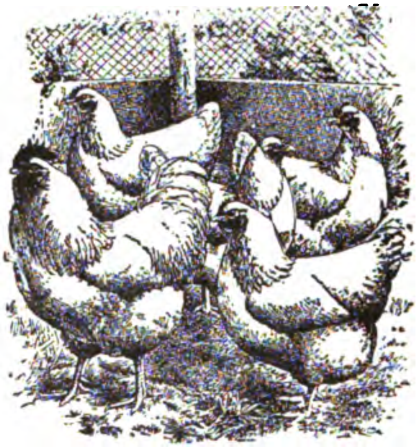
BARRED PLYMOUTH ROCKS.

The purchase of the stock itself is a problem indeed; for not one beginner in ten realizes that he is laying the foundation of a future enterprise with which he may concern himself the remainder of his days. It must be remembered that if a beginning is made with cheap stock that only cheap stock will be raised, while if high quality stock be used for a foundation the very first season will find the breeder's yards filled with a flock of high class fowls.

The selection of a breed is but the first step for a beginner. Success depends upon the loyalty that the new breeder shows to the variety of his choice and the energy and determination he possesses and exerts in bringing his flock to the highest state of perfection and production.

THE PLYMOUTH ROCK.

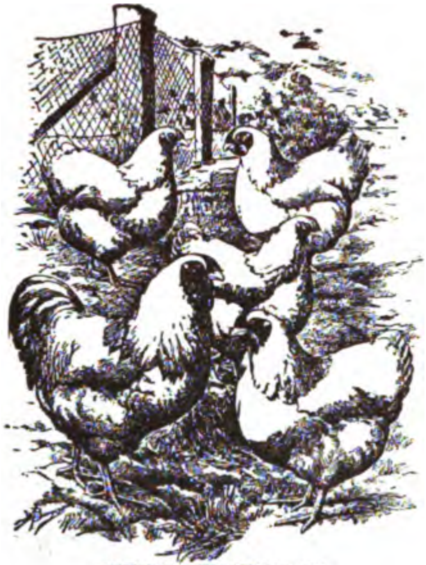
There are six varieties of Plymouth Rocks, the Barred, White, Buff, Columbian, Partridge and Silver Penciled. In size, type and economic qualities they are all the same and differ only in color. The Plymouth Rock has long been a farm favorite, the Barred variety having been much more commonly seen. They are good layers of medium sized eggs which vary in color though, different shades of brown. From Plymouth Rocks as large a winter egg production can be obtained as from any breed. Among the general purpose breeds Plymouth Rocks are excelled in size only by the Orpington and Langshan. Plymouth Rocks are good foragers but stand confinement well; they grow rapidly and make both excellent breeders and roasters.



WHITE PLYMOUTH ROCKS.

WYANDOTTES.

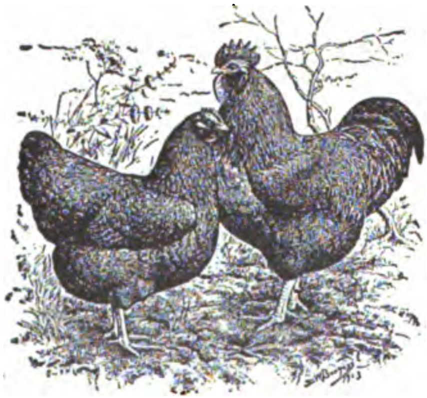
The eight varieties of Wyandottes are the Silver, Golden, White, Buff, Black, Partridge, Silver Penciled and Columbian. The Silver was the original variety; the White is the most popular. To all practical purposes the different varieties differ only in color. Wyandottes are slightly smaller than Plymouth Rocks and in shape are plumper and shorter bodied. Their economic qualities are the same as those of the Plymouth Rock. By some they are claimed to make better broilers and to be more economically kept. Wyandottes have low, close-fitting, rose combs which seldom suffer from frosting.



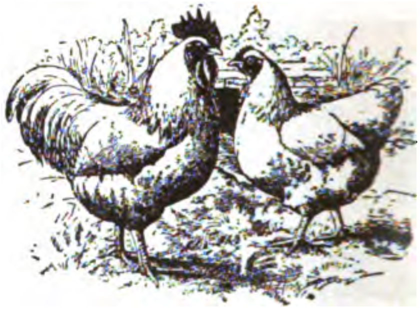
WHITE WYANDOTTES.

ORPINGTONS.

This is the largest of the clean-legged breeds of poultry as well as the largest of the admitted general purpose breeds. Only three varieties—the Buff, White and Black —are recognized by the American Poultry Association, although the Blue and Diamond Jubilee varieties are bred in some number, particularly in England where they have received a fuller recognition. They are good layers the year round, make excellent broilers and roasters and as capons rank with the very best. The Orpingtons are of English origin and have the white skin and legs which in that country are preferred to yellow.



BUFF ORPINGTONS.



WHITE ORPINGTONS.

LANGSHANS.

Langshans are bred in two varieties—Black and White, but the Black variety is much the more popular and the description given here is meant to apply particularly to that variety.

BLACK LANGSHANS.

The Langshan is the most active of all the feather-legged breeds and is the only one that deserves practical recognition as a general purpose fowl. It has obtained much vor as a practical farm fowl and in acity and economic qualities ranks with the ymouth Rock and Wyandotte. The eggs the Langshan are slightly larger and are a more decided brown tint than those of e American varieties.

Langshans have a white skin and make xcellent capons, broilers and roasters, alough their black plumage is by some conidered a handicap as a market fowl.

RHODE ISLAND REDS.

Rhode Island Reds are bred in two vari-ties—the Single Comb and Rose Comb. They differ in no other respect save comb.

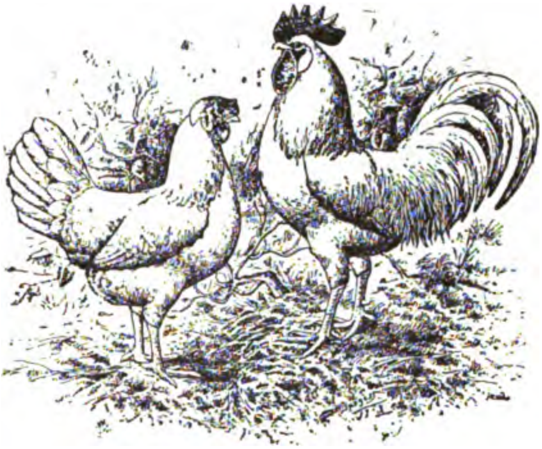
SINGLE COMB RHODE ISLAND REDS.

They are of the same size as the Wyandottes but differ from them very much in shape, being longer in back and having a much rangier appearance throughout. Of recent years they have become very popular as a farm fowl, being the only breed that ever threatened the Barred Plymouth Rock's standing in this respect.

They are good year round layers; mature quickly and make good broilers or roasters, also good capons. They are admittedly one of the most valuable of general purpose fowls. They are good rangers and stand confinement without chafing.

LEGHORNS.

We have five varieties of Leghorns according to color—the Brown, White, Buff, Black and Silver. Of these the first three are further subdivided according to comb, there being both Rose and Single comb varieties in the Brown, White and Buff. Leghorns are non-sitters, lay white eggs of good size and are generally accredited with being one of the best laying breeds. As foragers they are unexcelled, but stand confinement well. They are more nervous than the larger breeds and are more easily excited. They are small in size and mature early. The chicks make profitable broilers but as roasters they harden too quickly.



SINGLE COMB WHITE LEGHORNS.

THE LIGHT BRAHMAS.

The Light Brahma is the largest of all breeds of poultry recognized in this country. It is not commonly classed among general purpose breeds of poultry.

In districts where caponizing is much practiced the Brahma rises to its greatest economic value. Brahmas and Brahma crosses are most desired for caponizing purposes as they attain to the largest size and possess an excellent quality of flesh. As layers many other breeds are superior.

LIGHT BRAHMAS.

The Dark Brahma is smaller in size than the Light; does not equal it in value for capons or soft roasters and does not rank any better as a layer.

PEKIN DUCKS.

The Pekin Duck is the leading market duck of America. It is a rapid grower and the ducklings are ready for market at from eight to ten weeks of age, when they will weigh six pounds or more per pair. With ducks as with cockerels the greatest profit is made by marketing them as soon after they reach a profitable age as possible. Adult ducks seldom bring a price on the market that offers any profit for their rearing, while the eight and ten week old duckling will be a money maker. Ducks make rapid growth and are voracious eaters. The most profitable method of feeding ducks is to make a large part of their ration a mash in which vegetables are cooked and containing a good percentage of meat food. Grain of course is relished by ducks and should be supplied in moderate quantities; the greater part of the food supplied, however, for economical results should be soft feed and mash. An ample supply of drinking water must be kept close to the feeding place. The duck does not drink a greater amount of water than the hen but when eating soft feed will make frequent trips to the water pan for the purpose of cleaning and rinsing the mouth and nostrils. Have the watering vessel sufficiently deep for the duck to immerse its bill up to the eyes. Ducks are not subject to vermin and are afflicted with few diseases. The most common trouble among adult ducks is a rheumatic leg weakness which strangely enough is caused by keeping them in damp sleeping quarters. If the floors and litter in the house are kept dry this trouble will not appear. The Pekin Duck will lay almost daily during the late winter and early summer and the fertility of the eggs is usually high. Hens or incubators make the best hatchers for duck eggs. Ducklings are easily reared by artificial means. Ducklings should be fed six or eight times daily with a wet mash of bran, corn meal, shorts, beef scrap and cooked vegetables. Young ducks need no water for swimming purposes but drinking water must be supplied as for adult ducks. Young ducks must be kept out of

PEKIN DUCKS.

the sun during warm weather. Feathers are a considerable source of revenue where ducks are kept; they are not plucked annually like geese but when dressing all the soft body feathers should be saved and are worth from fifty to seventy-five cents per pound.

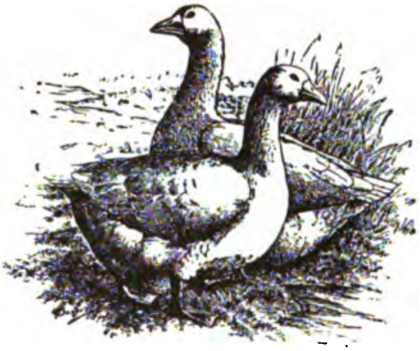
INDIAN RUNNER DUCKS.

The Indian Runner Duck is called the Leghorn of the duck family and is reputed to be the heaviest laying of all ducks. Indian Runners are bred in three varieties, the White, Fawn and White and English Penciled. The three varieties have the same economic qualities and differ only in color. This duck gets its name from its erect carriage and the fact that it does not waddle like other breeds. Although the Indian Runner Duck is not as large as the Pekin it nevertheless is an excellent market duck but is kept by many for egg production. The friends of the Indian Runner claim for it that it will lay as many eggs per year as the average hen and that in localities where there is a ready market for duck eggs it is a most profitable fowl to keep.

INDIAN RUNNER DUCKS.

GEESE.

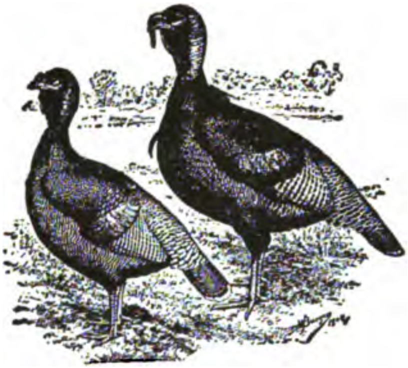
The popular varieties of the goose family are the Toulouse, the Embden and the African. These are the largest varieties of geese and of these three the Toulouse are the largest. The goose receives and really requires little attention on the farm. The adults are capable of taking care of themselves under almost any conditions. The goose is a great forager and when available grass is a large part of its food. The ganders are apt to prove pugnacious and are something of a nuisance in the poultry yard. Some keepers of geese pluck them annually for their feathers but for the most part they are kept to supply a feast for the big holiday dinners. The goslings make rapid growth and are hardy. They should be fed frequently when young or until they can forage in the fields. Geese are seldom seen in large flocks. They are not as prolific as the hen or duck. Commercial ventures in goose raising have not proved tempting.



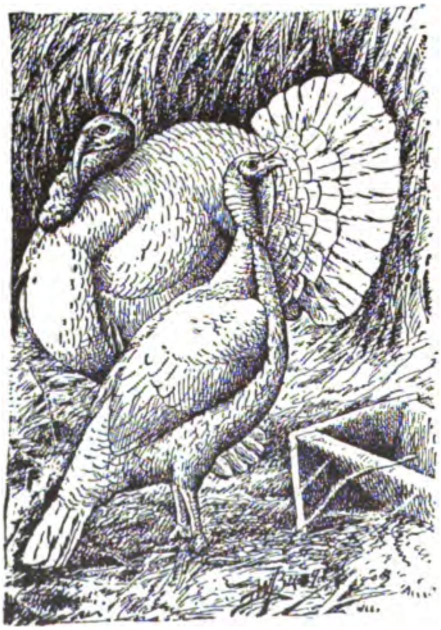
EMBDEN GEESE.

TURKEYS.

The Bronze, White Holland and Bourbon Red turkeys are the popular varieties. The former is the largest and most commonly seen. The two latter varieties, while smaller, are none the less profitable. The adult turkey is one of the hardiest of all domesticated fowls. For the first six or eight weeks of their lives young turkeys require the closest of attention and must be kept up during wet days and dewy mornings. After that age, however, when they begin to "shoot the red," as it is called, they may be permitted the range of the fields where they will find most of their food until fall. Turkeys are profitable because of their fondness for range which keeps them away from the granary and when marketed their carcasses have cost the farmer little in foods. Turkeys are commonly marketed alive prior to the Thanksgiving or Christmas holidays and prices are invariably such as to bring a considerable profit into the hands of him or her who has a good flock to sell.



BRONZE TURKEYS.



WHITE HOLLAND TURKEYS.

ARTIFICIAL INCUBATION AND BROODING.

It is not practicable to produce any considerable number of chicks without the aid of artificial incubation. The question is not whether incubators are superior to hens as hatchers but is one of getting good results from the incubator because it must be accepted as a necessity. The best incubator is the cheapest—it will give larger hatches of better chicks and will prove more durable. Have faith in the machine, follow the direction of the manufacturer for operating it and above all exercise every care as to the fertility of the eggs you entrust to it—this is to be your task—the providing of hatchable eggs, and if attended to satisfactory hatches will doubtless be the result. Do not expect 100 per cent hatches. Many poultrymen who have for years conducted successful practical poultry farms count sixty to seventy per cent a good average.

Any location where good ventilation and an equable temperature are found will prove a satisfactory location for the incubator. It is by no means necessary that it should be placed in a cellar, although such is an excellent place if well ventilated and free from bad odors. Observe religiously the instructions for turning and airing the eggs because on these largely depends the quality of the hatch and if neglected cripples and weaklings will be numerous. Do not keep the eggs for incubation in a cold cellar.

Keep them in an ordinary living room. Do not let your eggs chill at any time.

TRANSFERRING CHICKS TO THE BROODER.

Get the brooder ready two or three days before the hatch is coming off. Bed brooder with clean straw cut four to six inches long; no chaff or fine litter in brooder for first week. Put the chicks in brooder the next morning after hatch is over and do not feed until the oldest is 60 hours old. Open the doors only when necessary to remove shells, which should be done to prevent the telescoping of eggs. Have the brooder warmed up to the required point before transferring the chicks to it and if the weather is cold take care that the chicks are not exposed in the transfer. Bear in mind that a sudden though brief change from the 100 degree temperature of the incubator to an outdoor temperature of 30 degrees or less can do a lot of harm. For the first twelve or twenty-four hours in the brooder the chicks should be confined in the warmer section until they locate the warmer and cooler places. If this is not done they are likely to crowd into corners distant from the heat and become chilled. After they have located the source of heat they may be allowed the run of the entire brooder and will run into the cooler compartment where they will scratch and exercise lustily only to hurry back to the warmer compartment when they become cold. There is only one way to regulate the temperature of the brooder and that is by watching the chicks. If they are too hot or too cold their actions will plainly show it. If they crowd together and cheep dismally they are cold; if too hot they are not so noisy but nevertheless you will detect a note of discontent in their voices and will find the more robust ones panting with beaks open and wings distended. When everything is all right the voices of the chicks express supreme satisfaction—a pleasing little talking is going on while the little fellows scratch in the litter and scurry about. In mild weather the chicks may be permitted to run outside the brooder when four or five days old. If the weather is cold or inclement they should be kept in. A runway should be provided so that the chicks will not wander away. Later this can be removed unless other brooders are located near, in which case permanent runways are necessary because chicks even after they have become accustomed to one brooder will sometimes all of one accord crowd into another brooder, completely congesting it and leaving others empty.

FEEDING THE CHICKS.

If the chicks have been kept in the incubator 48 hours they should have their first meal soon after being removed to the brooder. The dry-feeding which is the safest is presented here first. Let the first feed be of grit. A white or light colored grit is preferable because this is the chick's first meal and something bright is needed to attract his attention. It is not intended of course that the chick be allowed to fill his crop with grit, but as the subsequent meal is to be of grain it is desired to get some grit into the crop so that grinding material will be on duty when the first food reaches the gizzard. Some of the chicks will prove surprisingly indifferent to the first meal but by tapping lightly on the floor of the brooder practically all can be induced to eat. When all have taken grit then the real meal begins. On the floor of the brooder or better on a paper spread for that purpose scatter prepared chick food. This is a mixture of cracked grain and seeds and can be obtained from almost any feed store. If not obtainable in your vicinity a mixture of finely cracked corn, crushed wheat, cut or clipped oats, millet seed, etc., will make a good substitute. Look carefully to the quality of the grains in the feed. If they smell sour or mouldy do not use them under any circumstances. Allow the chicks to eat plentifully of their first meal and provide water with the chill removed in some receptacle which prevents them wetting themselves. After fifteen or twenty minutes remove all food and tuck the chicks into the warm brooder compartment where, like a man after a full meal, they will show the perfect comfort they feel by taking a nap.

SHOULD BE FED OFTEN.

The chicks have now learned to eat and henceforth for several weeks should be fed five times daily. Provide plenty of fine soft litter, clover chaff preferred, and scatter the chick feed in this and let the little fellows scratch for it which they will do readily enough. In this way you keep them busy and provide the exercise needed while confined in the brooder. Fine grit and charcoal should be kept constantly before the chicks in boxes or hoppers and after the third day a small quantity of beef scrap should be supplied. It will result in increased growth and may be kept in hoppers if the chicks do not take too great a liking to it. If consumed in too large quantities, however, it causes scours and diarrhoea. Water must be supplied constantly and the vessels should be cleaned frequently and scalded. Fountains with tops, of the inverted can type, are best as they keep the chicks from getting in the water. Green foods in the form of lettuce, onion tops, steamed cut clover are valuable relishes and the chicks will eat them greedily. After several weeks the time between meals may be made longer, feeding first four and then three times daily. At the end of four weeks of age scratch feed may be substituted for chick feed. It is cheaper and has almost the same constituents only the grains are larger.

CARE AND MANAGEMENT FOR EGG PRODUCTION.

The logical time for penning pullets in their winter quarters is November first and to be ready for laying at that time they should have been hatched in March or early April if of the middle weight breeds and from four to six weeks later if of the nonweight varieties. Late hatched birds cannot be made to lay in early winter because they are not mature and their substance must go to growth if they are to develop into fowls of standard size and weight. There is no season of the year when eggs are scarcer on the average farm than in November—the old hens have not yet completed moult and the pullets have not yet begun laying. The period of high prices is beginning and an egg has several times the value that it will have in the late spring and summer months. Do not place birds of mixed ages in the laying pens. Select only those that are fully matured and in perfect health.

FOOD FOR LAYERS.

The procuring of eggs during the winter months depends upon the success with which the conditions that prevail during the natural laying season as to food and environment are imitated. The diet of the hen is more varied than that of any other farm animal and consists of cereals as represented by grains, whole or cracked and seeds; vegetables as represented by beets, cabbage, potatoes, turnips, onions, etc.; green foods as represented by grass, steamed alfalfa, sprouted oats, etc.; meat foods which when supplied must take the form of cut bone, beef scrap, beef meal, etc.; grit and oyster shell. Individual hens vary in their preference for different foods and as it is not possible to cater to the wants of each individual hen that ration is best which most nearly accords with the demands of the appetite of the average hen.

FEEDING A MIXED RATION.

A mixed grain ration fed in deep litter that will induce exercise is the basis of approved feeding methods. This grain mixture is frequently the commercial scratch feed composed of cracked corn, kaffir corn, wheat, oats, barley, buckwheat, sunflower, etc. The farmer, however, can compound his own mixture at a considerable saving in cost and will find that results are not appreciably different even when the variety of grains is much less than given above. Cracked corn, wheat and oats are available on any farm and make a very suitable scratching mixture. If located where kaffir corn is a crop it may be used with excellent results either to supplement Indian corn or as a substitute. Scratch feed should be fed in the litter twice or three times daily. Wheat or oat straw makes excellent litter for poultry houses and should be scattered over the floors of the house to a depth of six inches or more. The value of the method of feeding grain in litter rests upon the food and upon the fact that the fowls are literally forced to scratch for a living. The exercise obtained in scratching for the grains keeps the fowls busy, contented and warm. The last feed of the day given in the litter should be scattered early enough to allow the fowls to scratch out a good feed before dark. Busyness contributes to contentment among fowls just as among men and he who keeps his fowls hustling throughout the day will find his returns in the egg basket. When fowls are found on the roosts or huddled in the corners of the house on wintry days conditions are wrong and results will be poor.

THE SUPPLEMENTAL RATION.

To supplement the grain ration fed in the litter a mash composed of bran, corn meal, ground oats and beef scrap is necessary for best results. If a low grade flour can be secured to add to the ingredients of the mash at not too great a cost it is advisable to include it. Linseed meal, cottonseed meal and gluten meal, frequently recommended as components of laying mashes, give a better ration theoretically but their necessity is not borne out in practical experience, and as they are sometimes difficult to procure and almost invariably increase the cost of the mash unless one is particularly fortunate in location with reference to the sources of manufacture of these meals, it is not advisable to include them in a ration recommended for average farm use. A mash compounded of two parts bran, one part corn meal, one part ground oats, one part shorts or low grade flour and one part beef scrap is excellent. In beef scrap always demand the very best quality. This is a product, which if of poor quality will cause diarrhoea or scours in adult fowls and will sometimes cause large mortalities in chicks. A good beef scrap should be smooth and soft to the hand and should have an odor much like ground cracklings. Refuse any scrap that smells like decayed meat or contains any evidence of mould or rot. It is important, of course, to look well to the quality of all foods used but exercise the greatest caution when buying scrap.

GREEN FOOD FOR WINTER.

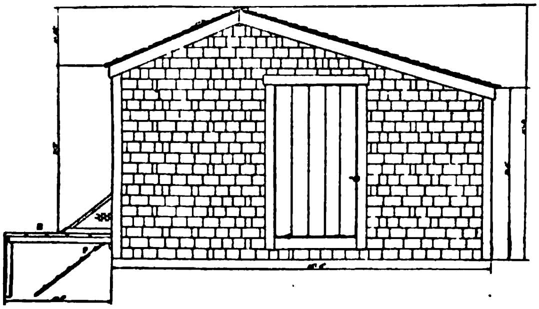
Sprouted oats have recently become a favored article for winter green food. Oat sprouters are manufactured by many concerns who manufacture poultry supplies and justify their cost in the rapidity with which they enable the farmer or poultryman to grow a supply of this succulent winter food. Oats can, however, be sprouted more slowly by placing a quantity of oats (only oats capable of germination can be used) in shallow boxes with bottoms which contain small cracks and holes for drainage and by keeping them in a place sufficiently warm to induce germination. The oats must be kept constantly wet without permitting water to gather in the boxes, as such an occurrence will cause mildew and kill the germinating properties of the oats. The boxes in which the oats are placed should be about three inches in depth and to prevent the top layer of oats from drying out a heavy wet cloth or burlap sack should be placed over each box. If properly cared for the oats will be ready to feed in from one to two weeks, depending upon the warmth of the room in which they are kept. The fine fibrous-like roots and the heavier sprouts will penetrate the whole mass, making of each box a solid mat which will come from the box in one section. A flock of one hundred hens will consume at one feeding a section of four to six square feet and it can be fed every other day with good results.

CLEAN WATER.

A constant and clean supply of water should of course be kept before the fowls at all times. If supplied often enough during cold weather to have a supply always before the fowls with the chill removed the good effect will be noticed. The type of vessel used should be such as to permit of easy and thorough cleaning and should be placed where litter and dirt can not be scratched into it.

PRACTICAL POULTRY HOUSES.

Poultry houses should be dry, well ventilated, without draughts and well lighted. If possible they should face the south and if such an exposure can not be provided an eastern frontage is next to be preferred. Too much glass is not an advantage as it permits of too great a loss of heat at night. Floors may be of cement, boards or dirt. Cement is permanent and gives a smooth surface for cleaning but is cold to the feet of the fowls and must be covered with several inches of sand or litter. Board floors are easily cleaned and warm but must be laid sufficiently high to permit of the dog or cat getting under them and the side walls of the house must extend entirely to the ground to keep the wind from under the

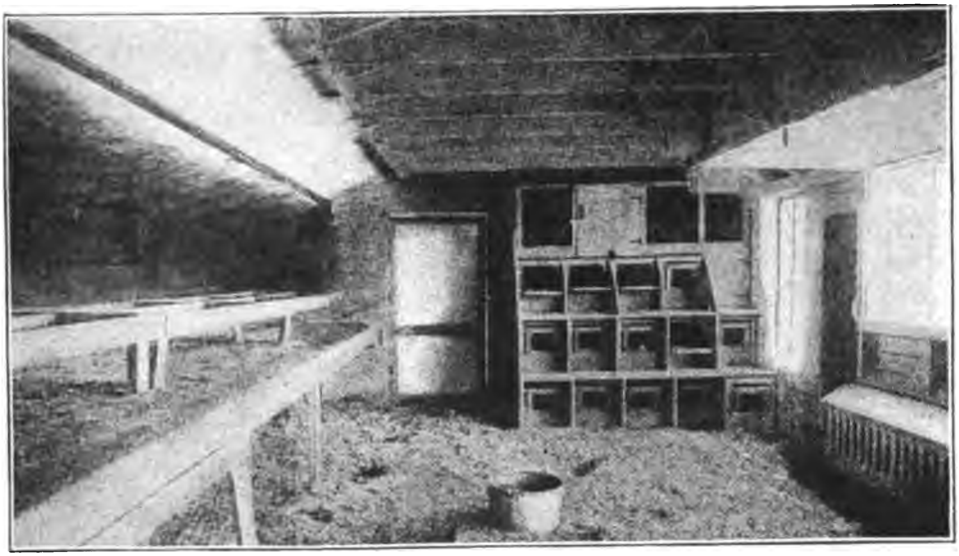


END ELEVATION OF MODEL POULTRY HOUSE.

floor. Dirt floors are most economical in original cost and are satisfactory for the fowls' comfort; however, they must be frequently renewed and are kept clean with more difficulty than floors presenting a smooth surface to the shovel or broom. Where dirt is used for a floor it should be filled in until six or eight inches higher than the level of the surrounding soil.

DOUBLE WALLED HOUSES NOT NECESSARY.

Although double walled houses are advocated by some the consensus of opinion is that the extra cost of such houses is not justified and few such are found. A single walled house made of matched lumber or of plain material with the joints well battened and lined with heavy building paper inside will prove warm enough for all practical purposes. Small holes and cracks should be stopped to prevent draughts. Either shingles or roofing paper make satisfactory roofs, the paper being preferred on roofs with small slope. Here more particularly than anywhere else in the house good material should be used.



INTERIOR OF MODEL POULTRY HOUSE.

On many farms will be found houses that possess all the requisites of a good poultry house and it is folly to think that a beginning cannot be made with poultry without first investing in new buildings. Existing poultry buildings on the average farm are likely to possess some of the following faults: wrong exposure, too much glass, too little provision for ventilation, inconvenient arrangements of roosts and dropping boards, exposure to draughts or too small for the number of fowls kept. Any of these faults can be remedied with little expense in most cases.

Practically all of the fowls on the average farm are kept in one house and if the number is large the house is almost invariably overcrowded. The only remedy for this is the building of an additional or new house. The most approved practice in management for winter egg production contemplates the confinement of the fowls to the house on many days and the house must provide sufficient room for scratching and exercise, and no more serious a mistake could be made than to crowd together in one lot more fowls than the house will provide with room and ventilation. At least six square feet of floor space should be provided for every fowl to be wintered in the house and if such space cannot be provided the extra hens should be disposed of.

A MODEL HOUSE.

If it is considered necessary to build a new house none is more deserving of recommendation than some form of the curtain front house of which a popular type is illustrated herewith. It is ideal for farm poultry raising as it contemplates the housing of fowls in colonies of the size that will incorporate the average farm flock of hens kept through the winter. In arrangements it is convenient and can be enlarged upon by simply building on new units as they are needed. In poultry raising it pays to make the fowls comfortable.

THE SILO IN MODERN AGRICULTURE

Several important points have to be observed in building silos. First of all, *the silo must be air-tight,* and the fodder well packed in it, so as to exclude the air as far as practicable. In the second place, *the silo must have smooth, perpendicular walls,* which will allow the mass to settle without forming cavities along the walls. In a deep silo the fodder will settle several feet during the first few days after filling. Any unevenness in the wall will prevent the mass from settling uniformly, and air spaces in the mass thus formed will cause the surrounding silage to spoil. *The walls must furthermore be rigid,* so as not to spring when the siloed fodder settles, on account of the lateral pressure in the silo, as air would thereby be admitted along the silo walls, causing decay and loss of silage.

PLANNING A SILO.

In planning a silo the first point to be decided is how large it shall be made. We will suppose that the farmer has a herd of twenty-five cows, to which he wishes to feed silage during the winter season, that is, for 180 days. As a rule, it will not be well to feed over forty pounds of silage daily per head. If this quantity be fed daily, on an average for a season of 180 days, we have for the twenty-five cows 180,000 pounds, or ninety tons. If ninety tons of silage is wanted, about one hundred tons of fodder corn must be placed in the silo.

We may take forty pounds as the average weight of one cubic foot of corn silage. One ton of silage will accordingly take up fifty cubic feet; and 100 tons, 5,000 cubic feet. If a rectangular one-hundred-ton silo is to be built, say 12x14 feet, it must then have a height of 30 feet. If a square silo is wanted it might be given dimensions 12x12x35 feet, or 13x13x30 feet.

The silo should always be emptied from the top in horizontal layers, and the surface kept level, so as to expose as little of the silage as possible to the air. It should be fed out rapidly enough to avoid spoiling of the silage; in ordinary northern winter weather a layer of a couple of inches should be fed off daily. It is estimated that there should be a feeding surface in the silo of about five square feet per cow in the herd; a herd of thirty cows will then require 150 square feet of feeding surface, or the inside diameter of the silo should be 14 feet; for a herd of forty cows a silo with a diameter of 16 feet will be required; for fifty cows, a diameter of 18 feet; for one hundred cows, a diameter of 25¼ feet, etc.

FORM OF SILOS.

One of the essentials in silo building is that there shall be a minimum of surface and wall exposure of the silage, as both the cost and the danger from losses through spoiling are thereby reduced. The round silos are superior to all other forms in regard to this point, the cylindrical form being also the most economical to build of the three types, because lighter material and less of it may be used in their construction. Silage of all kinds will usually begin to spoil after a few days, if left exposed to the air; hence the necessity of considering the extent of surface exposure of silage in the silo while it is being fed out. In a deep silo there is less silage exposed in the surface layer in proportion to the contents than in shallow silos.

LOCATION.

The feeding of the silage is an every-day job during the whole winter and spring, and twice a day at that. The silo should be as handy to get at from the barn as possible. If the ground is dry outside the barn, the best plan is to build the silo there, in connection with the barn, going 4 to 6 feet be-

FILLING THE SILO.

low the surface, and providing for doors opening directly into the barn. The bottom of the silo should be on or below the level where the cattle stand, and, if practicable, the silage should be moved out and placed before the cows at a single handling. While it is important to have the silo near at hand, it should be so located, in case the silage is used for milk production, that silage odors do not penetrate the whole stable, at milking or at other times.

BOTTOM OF SILO.

The bottom of the silo may be clay, or preferably, a layer of small stones covered with cement. In some silos considerable damage is done by rats burrowing their way into the silo from below, and destroying a great deal of silage, both directly and indirectly, by admitting air into the silo. The silo may be built four to six feet down into the ground, if this is dry. Stave silos are built entirely above ground.

The silo should rest on a substantial stone foundation, to prevent the bottom from rotting and to guard against spreading of the wall. The foundation wall should be 18 to 24 inches thick and it has been suggested that the bottom of the silo should be placed one foot below the ground, so that the stone wall on which it rests may be sustained by the earth on the outside.

THE BUILDING OF A SILO.

The silo should rest on a substantial stone foundation, to prevent the bottom of the silo from rotting and to guard against spreading of the silo wall. The foundation wall should be eighteen to twenty-four inches thick.

As there is a considerable lateral pressure in the silo before the fodder has settled, it is very important to make the walls rigid and to place the studding sufficiently close together to prevent spreading of the wall.

When the silage has settled there is no lateral pressure in the silo. While silos provided with partitions must be filled simultaneously on both sides of the partition to avoid bulging or even breaking of the partition, the silage in one compartment can be completely removed before that in the other is uncovered, without causing the partition to spring.

To insure ventilation in rectangular wooden silos, the sills may be two inches narrower than the studding, so as to leave air spaces between the sills and the lining; in the same way the plate is made narrower than the studding to provide for an escape at the top. The same end may be reached by boring a series of holes at the bottom of the outside wall between every two studs, leaving an open space of about two inches on the inside at the top of the plate. Wire nettings should be nailed over ventilation openings to keep out rats and mice.

Where the silo is built in the bay of the barn, there will be no need of making any separate roof, which otherwise generally will be the case. The roof may be either board or shingle and should be provided with a cupola, so as to allow free ventilation in the silo. In extreme cold weather this should be shut, to prevent freezing of the silage.

Silos are at the present built almost exclusively of wood, stone, or concrete, or partly of one, partly of another of these materials.

CROPS FOR THE SILO.

The ideal silage corn is a variety having a tall, slender, short-jointed stalk, well eared, and bearing an abundance of foliage. The leaves and ears should make up a large percentage of the total weight, and the yield per acre should be heavy. The lower leaves should keep green until the crop is ready to harvest, and it is desirable to have the plant stool well and throw out tall, grain-bearing suckers. A silage variety should mature late, the later the better, so long as it only matures, as a long-growing, late-maturing sort will furnish much more feed from a given area than one that ripens early.

THICKNESS OF PLANTING.

In planting corn for the silo we want the largest quantities of food materials that the land is capable of producing. This, evidently, can be obtained by a medium thickness of planting. If too thin or too thick planting be practiced, the total yields of food materials obtained will be decreased—in the former case, because of the small stand of plants; in the latter, because of insufficiency of light, moisture, and other conditions necessary to bring the plants forward to full growth.

Corn should be planted in hills or drills, and not broadcast. The objection to sowing corn broadcast is that the land can not be kept free from weeds in this case, except by hand labor; that more seed is required, and that plants will shade one another, and therefore not reach full development, from lack of sufficient sunshine and moisture. As a result, the yield will be greatly diminished.

WHEN TO HARVEST.

The largest amount of food materials in the corn crop is not obtained until the corn is well ripened. When a corn plant has reached its total growth in height, it has attained only one-third to one-half the weight of dry matter it will gain if left to grow to maturity; and although there is a slight decrease in the digestibility of the dry matter and a marked decrease in that of the crude protein and crude fiber with the greater maturity of the fodder, we nevertheless find that the general practice of cutting corn for the silo at the time when the fruit has reached the roasting-ear stage, is good science, and in accord with our best knowledge on the subject.

CLOVER AND ALFALFA SILAGE.

When properly made, clover silage is an ideal feed for nearly all kinds of stock. Aside from its higher protein content it has an advantage over corn silage in point of lower cost production.

The common practice of farmers is to cut clover for the silo when in full bloom, or when the first single heads are beginning to wilt, that is, when right for haymaking, and we notice that the teachings of the investigations made are in conformity with this practice.

What has been said in regard to the siloing of clover refers to alfalfa as well. Alfalfa silage compares favorably with clover silage, both in chemical composition and in feeding value. It is richer in flesh-forming substances (protein) than clover silage, or any other kind of silage, and makes a most valuable feed for farm animals, especially young stock and dairy cows.

OTHER SILAGE CROPS.

Sorghum for silage is sown in drills, three and one-half inches apart, with a stalk every six to ten inches in the row, and is cut when the kernels are in the dough stage, or before. According to Shelton, the medium-growing saccharine and non-saccharine sorghums are all excellent silage materials. The sorghums are less liable to damage by insects than corn, and they remain green far into the fall, so that the work of filling the silo may be carried on long after the corn is ripe and the stalks all dried up. The yield per acre of green sorghum will often reach twenty tons, or one-half as much again as a good crop of corn.

Cow-pea silage is greatly relished by farm animals after they once become accustomed to its peculiar flavor; farmers who have had considerable practical experience in feeding this silage are of the opinion that cow-pea silage has no equal as a food for cows and sheep. It is also a good hog food, and for all these animals is considered greatly superior to pea-vine hay.

Soja beans (*soy beans*) are another valuable silage crop. The vigorous late varieties are well adapted for silage. The crop is frequently siloed with corn (two parts of the latter to one of the former), and like other legumes it improves the silage by tending to counteract the acid reaction of corn silage.

MIXED SILAGE.

The mixture is made up of cut Indian corn, sunflower seed heads, and horse beans in the proportion of one acre corn, one-half acre horse beans, and one-quarter acre sunflowers. The principle back of this practice is to furnish a feed richer in flesh-forming substances (protein) than corn, and thus avoid the purchase of large quantities of expensive protein foods, like bran, oil meal, etc. Feeding experiments conducted with the mixture have given very satisfactory results, and have shown that this silage mixture can be partly substituted for the grain ration of milch cows, without causing loss of flesh or lessening the production of milk or fat. Fifteen pounds of this silage may be considered equivalent to three to four pounds of grain feeds.

BEET PULP SILAGE.

In districts near sugar beet factories, where sugar beet pulp can be obtained in large quantities and at a trifling cost, stock feeders and dairymen have a most valuable aid in preserving the pulp in the silo. As the pulp is taken from the factory it contains about ninety per cent of water. The pulp packs well in the silo, being heavy, finely divided and homogeneous, and a more shallow silo can therefore be safely used in making pulp silage than is required in siloing corn, and especially clover and other crops of similar character. If pulp is siloed with other fodder crops, it is preferably placed uppermost, for the reason stated. Beet tops and pulp may also be siloed in alternate layers in pits three to four feet deep, and covered with boards and a layer of dirt.

FILLING THE SILO.

If the corn is to be cut before being filled into the silo, it is unloaded on the table of the fodder-cutter and run through the cutter, after which the carrier elevates it to the silo window and delivers it into the silo.

The length of cutting practiced differs somewhat with different farmers, and according to variety of corn to be siloed. The general practice is to cut the corn in one-half to one-inch lengths, a few cut in two-inch lengths. The corn will pack better in the silo the finer it is cut, and cattle will eat the larger varieties cleaner if cut into inch lengths or less. On the other hand, it is possible that fine cutting implies larger losses through fermentations in the silo; fine-cut silage may, furthermore, not keep as long as silage cut longer after having been taken out of the silo.

INVENTIONS MINIMIZING FARM LABOR

NEW INVENTION DOES TEN MEN'S WORK WITH ONE, AND DOUBLES VALUE OF CROP.

By courtesy of the McCormick Division, International Harvester Co.
MANUFACTURING BINDER TWINE.

Farm labor, like everything else, has undergone a great change during the last fifty years. Previous to that time, almost everything was done by hand. The sickle, scythe and cradle have been supplanted by inventions that would make the heads of our forefathers reel with amazement.

The reaper, a machine designed to harvest small grain such as wheat, oats, barley and rye, was invented in 1831 by Cyrus H. McCormick. Prior to that time wheat and other grains were gathered by hand with the cradle, which had superseded the reaping hook. Since its invention the importance of the reaping machine has been recognized by the world. During the years of the early development of the reaper the Hon. Wm. H. Seward said: "It moved the line of civilization westward thirty miles every year."

By courtesy of the McCormick Division, International Harvester Co.
BORING KNOTTER FRAMES.

The first reaping machine built by McCormick in 1831, and operated in the harvest of that year, was the prototype of the harvesting machine industry that has grown to the stupendous proportions which characterize it at the present time. To-day more than 3,000,000 McCormick machines are in use throughout the world. Inasmuch as each machine does the work of ten men, the McCormick machines in use are equivalent to an army of 30,000,000 men. These machines have multiplied the world's production of wheat many times, thus banishing the fear of famine, and making flour so abundant that the best bread is no longer a luxury.

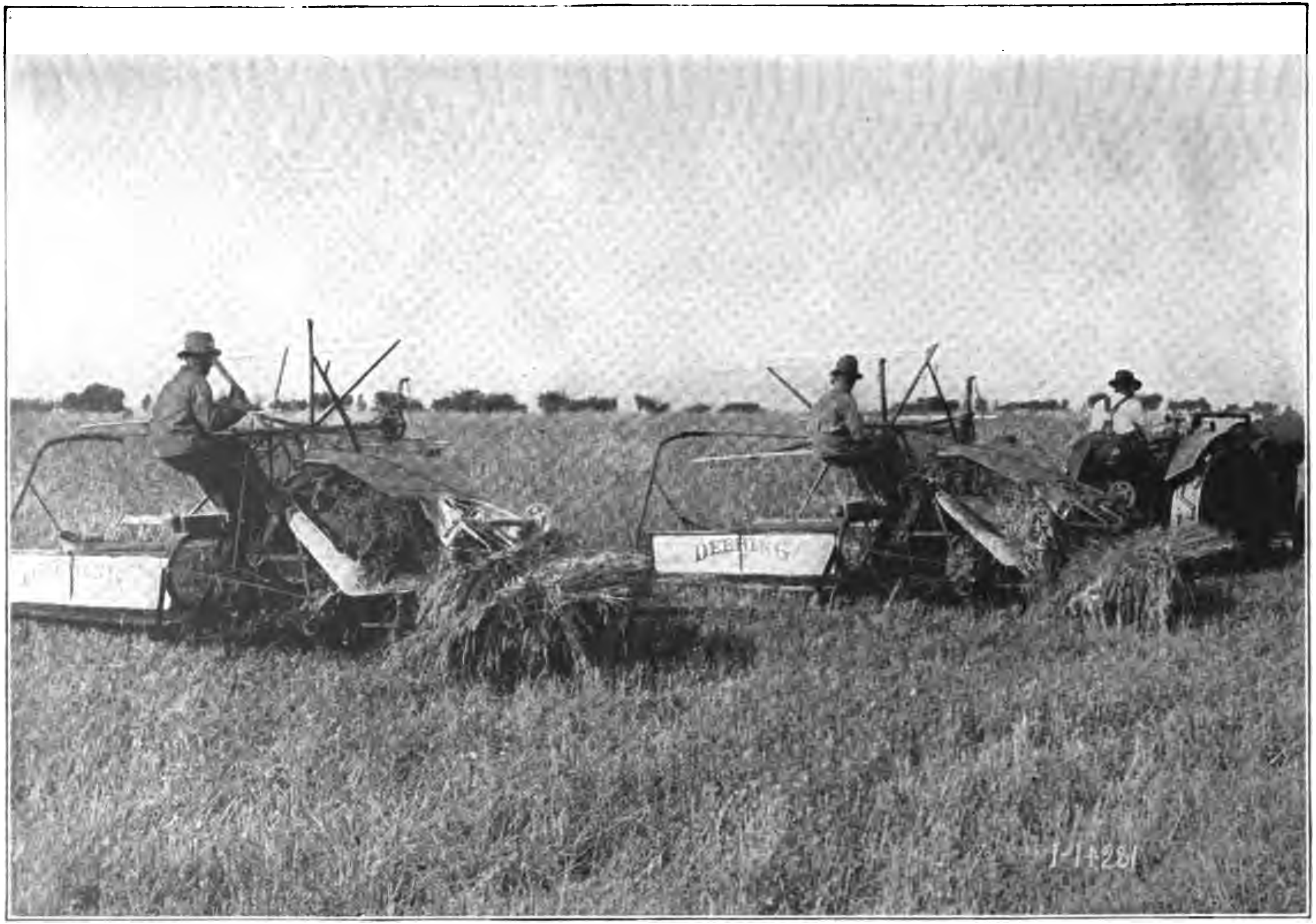
Harvesting machines now embrace binders, reapers, headers, header-binders, rice binders, mowers, hay rakes, corn binders and huskers and shredders. The binder, the most improved type of harvesting machine, will cut and bind 15 acres of wheat in a day of ten hours. The machine requires only one man to operate it, while the work it does is equivalent to the work of ten able bodied men. Moreover, the work done by the machine is in every way superior to that done by hand.

SHREDDING CORN.

The introduction of the husker and shredder has greatly assisted the farmer in handling the corn crop. The machine husks the corn and shreds the fodder, leaves and husks into feed that is worth as much as timothy hay. By handling the corn crop with machines, the corn grower saves all of his crop—the ears as well as the stalks—thus practically doubling the value of the corn crop, inasmuch as the stalks in former years have gone to waste in the field.

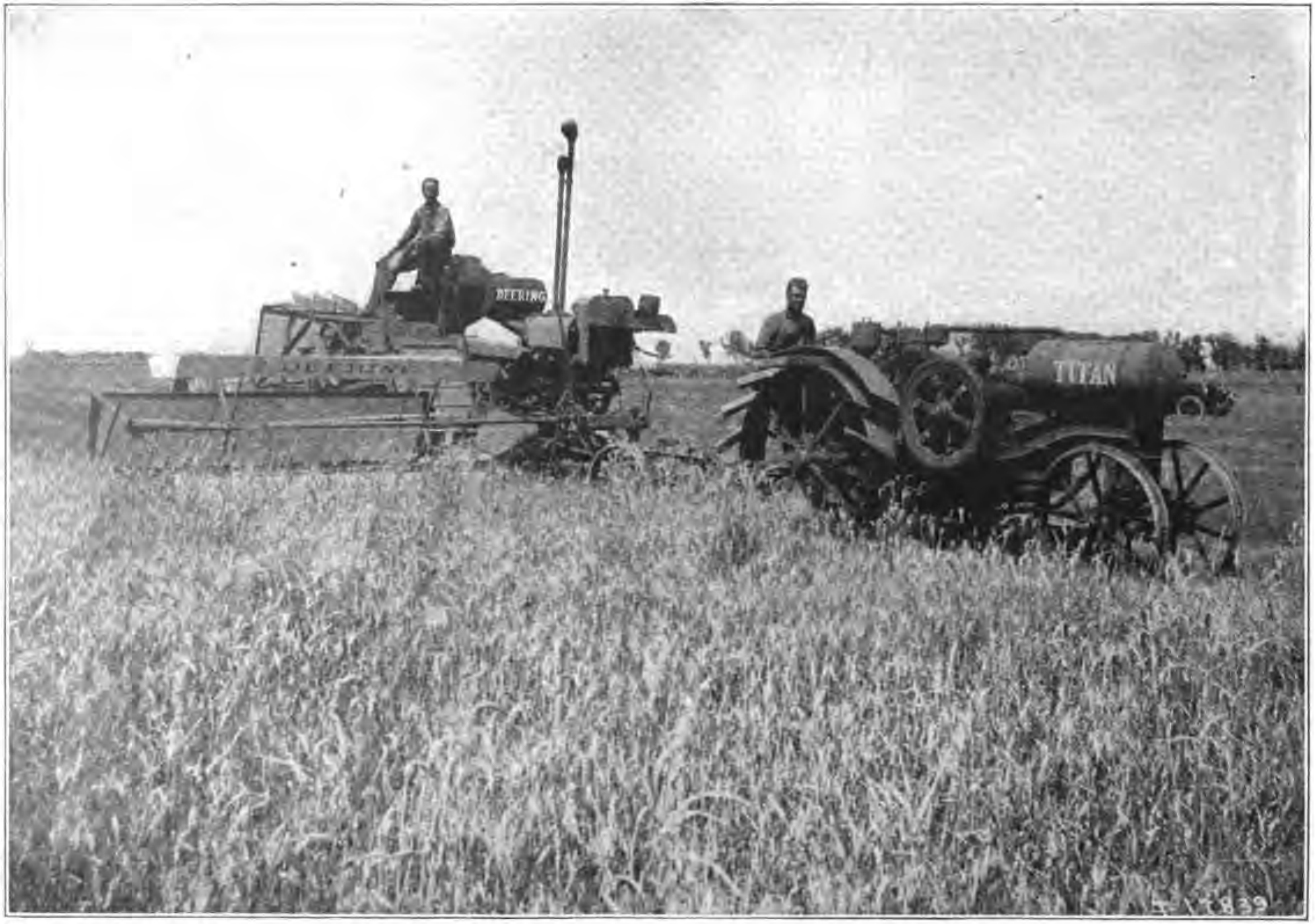
HARVESTING WITH A SELF BINDER.

Not many decades ago binding was done by hand, and harvesters "bound their stations." Now binding is done by machinery. The most ingenious mechanisms now tie the bundles with strong manilla twine.



MODERN HARVESTING METHODS. Courtesy of International Harvester Co.

The tractor is drawing two eight-foot binders or a swathe of sixteen feet is being cut. By the use of the tractor hitch as many binders can be operated behind the tractor, each cutting its swathe and turning corners with ease as the tractor can pull. The end of a long line of development from the sickle cutting days of the Middle Ages.



THE. HARVESTER-THRESHER. Courtesy of International Harvester Co.

The final triumph in harvesting methods. This machine does all the work of harvesting at one operation, that is the cutting, threshing, and cleaning of the grain. Throughout sections where machines of this kind are used, they are commonly referred to as combines. The name "harvester-thresher" applies to the same kind of machine and is used because it describes the work that the machine does. It is drawn by a kerosene tractor and will harvest from fifteen to twenty acres a day.

THE SEWING MACHINE AND KNITTING MACHINE

SAVING WOMAN'S LABOR AND LESSENING EXPENDITURE.

HOW SEWING IS DONE TODAY.

Among the many inventions which have come to the front in the last 50 years is that of the sewing machine. Compare, if you will, the time saved by the use of the modern, up-to-date sewing machine and the work done in the old manner, by hand.

In the sewing machine as in many other inventions America leads the world. Not only is this true of the machine used in the family, but of machines used in manufacturing, for stitching all kinds of textile fabrics and leather, including special machines for buttonholes, eyelets, over-seaming, embroidery, etc.

The idea of sewing by machinery had been cherished for a hundred years before the first successful machine was made. Passing the records made by Thomas Saint, in 1790, and Duncan in 1804, both of England, and those of Dodge (1818) and Lye (1826), both of the United States, because it does not appear that either of their inventions was of practical use, we find that, in 1830, Barthlemy Thimonnier patented a sewing machine in France, which was so successful that, in 1841, 80 of them, made of wood, were in use for sewing army clothes at a shop in Paris.

Several sewing machines, having more or less merit, were constructed in the United States during the first half of the 19th cen-

BEFORE THE TIME OF THE SEWING MACHINE.

tury, the nearest approach to success, prior to 1850, having been made by Walter Hunt, in 1832. No serious attempts were made by him to exploit his invention, nor was it of any benefit until Isaac M. Singer, in 1850, perfected the improvements necessary to make Hunt's product of real utility, and produced the first sewing machine having any practical value. In 1851, Allen B. Wilson took out patents for a sewing machine having a revolving hook for making the double lock-stitch. Other inventors closely followed, and we find that six different manufacturers made about twenty-five hundred machines in 1853. None of these has survived, excepting Singer's and Wilson's. The annual product of the machines developed from these inventions now runs into millions, and they are sent to the remotest parts of the entire world. The most remarkable phase of this development has been the adaptation of sewing machines for special uses in a great variety of manufactures.

In addition to machines of the best type for family sewing, a single manufacturing company makes more than 70 distinct classes, or types, of sewing machines for every stitching process used in manufacture; these classes are fitted with attachments, or devices, for special processes, and there are more than six hundred distinct varieties of Singer machines. There are machines making twelve, or more, seams at once; machines, also, that hemstitch and tuck; machines that ruffle and tuck; machines for stitching books and boots, sewing on buttons and making the buttonholes; in short, the American sewing machine of to-day stitches everything capable of needle perforation, from lace to leather. This development of special stitching appliances for factory operation has been of tremendous benefit to the world, because it has caused a great reduction in the cost to the consumer of many articles in common use.

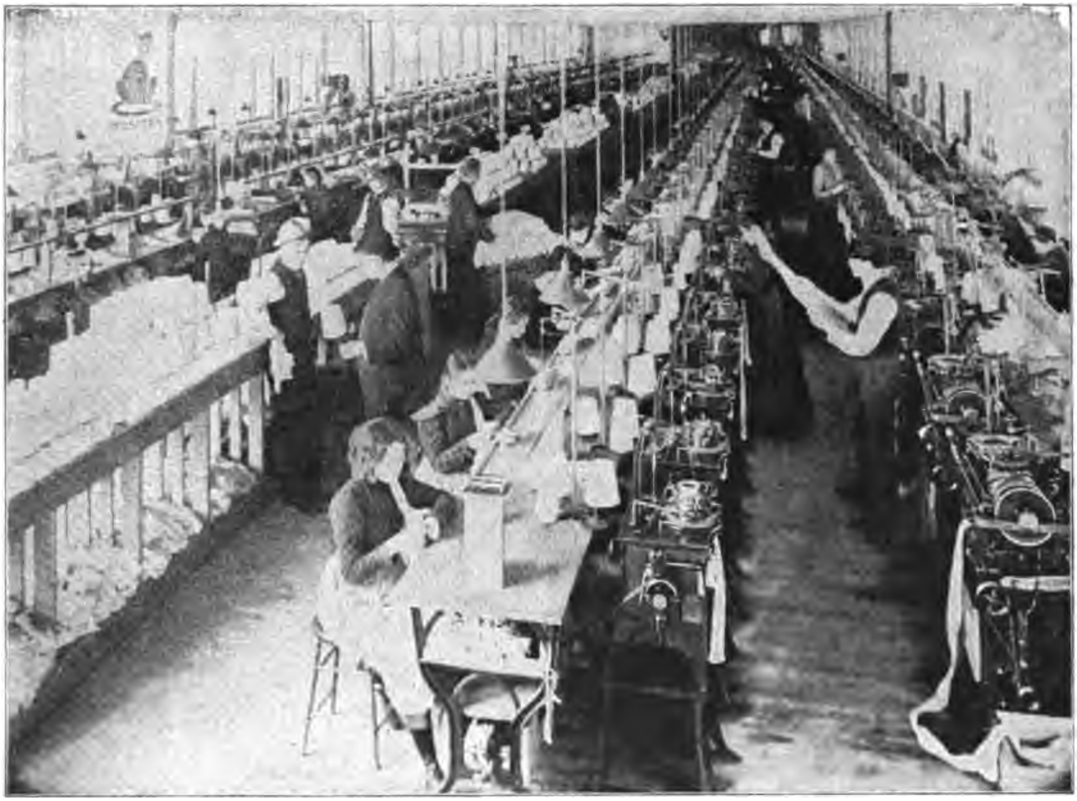
Because of this fact, the quantity of sewing done in the home has been greatly reduced, and the finished garment can often be bought for the former cost of the material. Thus, domestic burdens have been correspondingly lessened, and this result may fairly be claimed as due to the inventive genius and executive ability in the field of sewing-machine manufacture.

THE KNITTING MACHINE.

Much of the foregoing comment as to the effect of the sewing machine in lightening the task of the mistress of the household, as well as in lessening the expense incurred for clothing the family, may properly apply to the results attending the introduction of the knitting machine. The enterprise of knitting by machinery has already attained large proportions.

Knitting is a branch of industry which may be termed the twin sister of sewing. The first device ever invented to replace hand work in knitting stockings was the stocking frame, contrived in 1589 by William Lee, of Woodborough, in Nottinghamshire, England. The invention, limited in scope as it was, resulted in making the stocking trade one of the chief industries of the Midlands, for it was the precursor of many ingenious contrivances in this line.

The modern, upright, rotary knitting machine has two cylinders or heads. Each head generally knits four threads at once, and each thread, or the machinery necessary to knit it, is called a feed. One girl can attend to six cylinders. The needles used are the spring-beard, and they are placed in a mold in pairs, and leaded by having a composition consisting of equal parts of lead and tin poured around them. The gauge is determined by measuring the needles and counting the leads, when set in the cylinder. For instance, 14-gauge has 14 leads, or 28 needles, 3 inches in length, measured on the circumference. A single-cylinder apparatus of 22 inches diameter, 20-gauge, 4 feeds, knitting common hosiery, yarn, cotton and wool mixed, running 45 revolutions, has 920 needles, thus making 165,000 stitches per minute. A 16-inch cylinder, 20-gauge, 4 feeds, cotton yarn, has run 79 revolutions and made 212,532 stitches per minute. Usually, an 18-inch cylinder, 15-inch gauge, is run 45 revolutions; and a table of two heads turns off 160 pounds of knit cloth, per day of 11 hours.

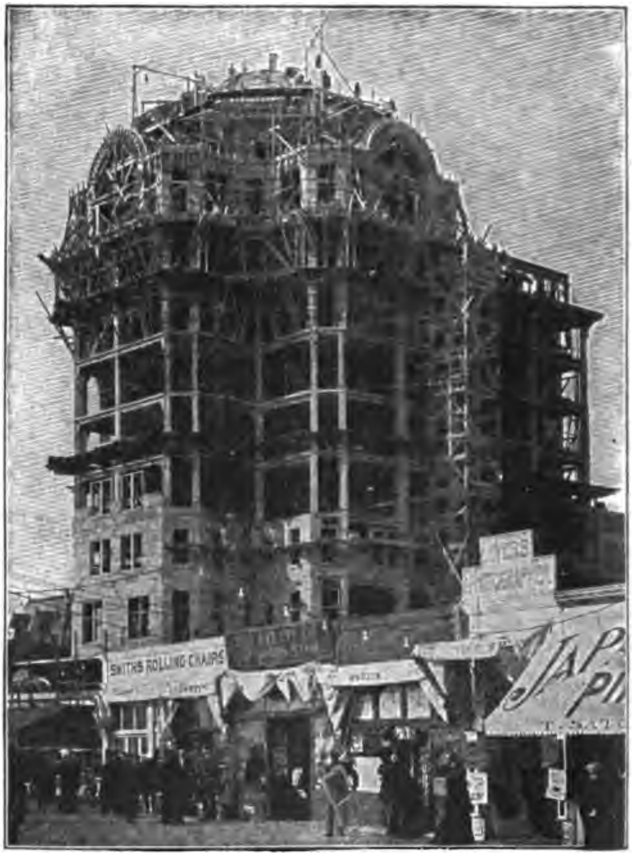


KNITTING MACHINE FACTORY.

Interior View, Showing Up-to-date Methods of Manufacturing Hosiery. This industry has sprung into prominence during the last fifteen years. Our grandmother's knitting needle is a weak competition with such an establishment as this.

THE BUILDING INDUSTRY

The building industry, which provides us with homes, stores, office buildings and the various buildings of modern life, is, necessarily, one of the great industries of the United States. In 1918 the total value of the buildings for which permits were issued in 52 of the principal cities of the United States was $530,403,525. The material used and methods employed in erecting large buildings has been completely changed in recent decades. Steel and concrete are the principal materials used. Some of the principal buildings in large cities are built entirely of reinforced concrete.



BUILT OF STEEL AND CONCRETE.

HOUSES OF CONCRETE.

In this connection, small houses have been moulded out of concrete. In Pittsburgh, 50 two-story cottages were thus erected. This is known as the Monocast system. Floors, walls and ceilings of these houses are all in one piece; grates are built into every room, and mantels are moulded in on the walls; shelving and cabinets are built in and sinks, bath and wash tubs are made fully as good as the usual articles, all of concrete. But the greatest change in building construction is in our large cities. Not many years ago a bird's-eye view of any large city would have shown an almost dead level of roofs with here and there some church spire breaking the monotony, but now such a view is entirely different. Immense office buildings and stores are continually rising above the level of surrounding buildings, which in turn surpass the modest heights of earlier years.

HOUSE CAST IN ONE PIECE.

CONSTRUCTION OF THE "SKY-SCRAPER"

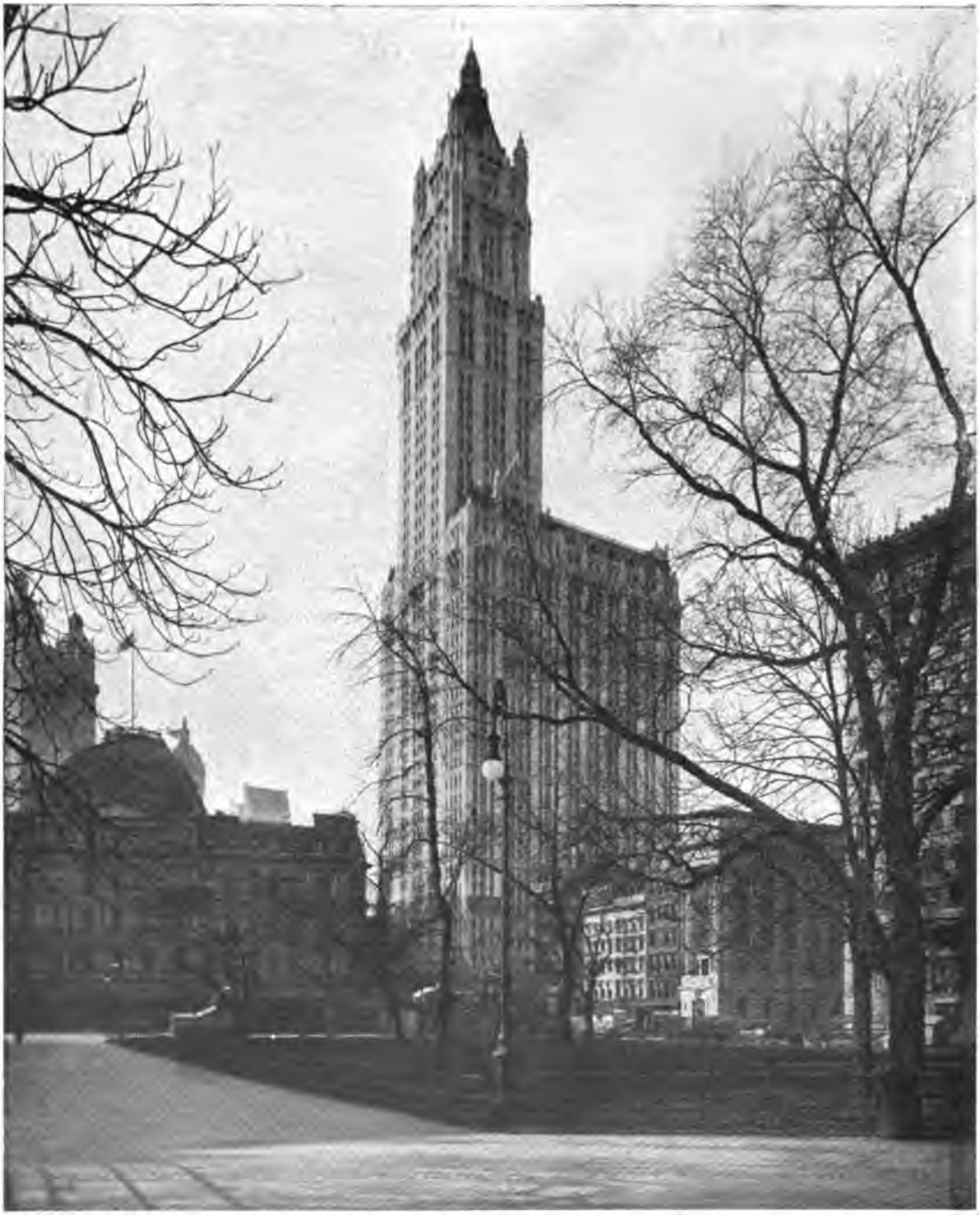
FLATIRON BUILDING, NEW YORK CITY.

Great has been the progress in building in the last decade. Time was when a ten-story office building would have been deemed an affront to Providence. But with the invention of the modern elevator and the rapid advance of land values in great cities, architects and contractors began seriously to study out methods for accommodating great numbers of tenants in individual buildings. As long as buildings had to be constructed solely of brick and masonry there was a definite limit to their height, for, as the height grew so grew the weight of the walls and further altitude had to be sacrificed when it became impossible to fit the walls to carry the height without undue expenditure.

At the junction of Fifth avenue, Broadway and Twenty-third street, New York, stands a unique structure, probably the strongest ever erected. It is known as the "flatiron" building, and is the cumulative result of all that is known in the art of building. It is equipped with every convenience that human ingenuity could devise.

BUILDING WALLS FROM THE UPPER STORIES DOWNWARD.

Suddenly there appeared an engineer who solved the problem by propounding the idea of building steel structures after the fashion of gigantic bridges set on end, and to hang the walls on—that is, to make the girders and beams support the floors and walls, instead of making the walls support everything. This was called Chicago construction, because it originated with a Chicago man. Building under this method each floor is absolutely independent so far as the walls and partitions are concerned, for the walls have



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THE WOOLWORTH BUILDING, NEW YORK.

At present the highest building in the world: 55 stories, 775 feet. The foundation piers are sunk 110 feet to bedrock.

nothing but their own weight to carry in the height of each story. It is no uncommon thing on "Chicago-construction" building for the contractor to begin his exterior work on the third, fifth or ninth story, leaving the first to be enclosed after every other floor has been walléd in and plastered. This method of building is diametrically opposed to the old-fashioned solid-masonry construction, which begins at the very bottom with the foundation and rises to the roof, with the piers, exterior walls and partition walls going up together. The contractor, building a skyscraper according to "Chicago construction," shoots the steel frame-work up as rapidly as possible, so as to get the roof on to protect the interior from the weather. With the frame-work up, he puts in the hollow tile partitions or builds the walls to suit his convenience. This method of building set all traditions, rules and time-honored customs of architects and builders at naught, for it ignored massive foundations, heavy piers, the use of thick walls to carry weight, and solid partition walls running from the foundation to the roof.

When new tenants moved into old-fashioned buildings, the rearrangement of spaces to meet the tenant's requirements frequently necessitated expensive alterations, for the partitions could not be moved without substituting some other form of supports for the floors above. Chicago's architectural engineers concluded that columns starting from the foundations could carry the floors as well as partitions, and would thus permit any arrangement of a floor without interfering with the construction.

High buildings required monstrous foundations and very thick walls under the solid masonry style of construction. The limited areas in the cramped business districts of the cities made it impossible to build 16-story buildings under old-fashioned methods because the builder could not get "spread" for his foundations, and the original soil of Chicago was not adapted for carrying weights on small areas.

THE ARCHITECTURAL IRON WORKER.

This style of new building developed a new craft—that of the architectural iron worker—who is a mixture of a bridge builder and a sailor. He must be a rigger as well as an iron worker, and must be able to tread the beams high in the air with the confidence and nerve of a tight-rope dancer. The building up of the great structures in the business center provided another source of wonder and admiration for the gaping crowds that watched the daring workmen riveting together angles and beams hundreds of feet in the air. Many sailors left the lakes and became iron workers, and the craft grew until it became one of the largest and strongest of unions.

OLD AND NEW STYLE FOUNDATIONS.

In solid masonry construction the foundations are made of heavy stones piled on each other so that they are broad at the base and somewhat pyramidal in form. On the foundation the massive piers rise, well-nigh filling up all the space in a basement. Under present methods of construction a basement, so far as room is concerned, is as valuable as the other floors, for the slender columns shoot up from the foundations, occupying comparatively little space. In "Chicago construction," the foundations are made of steel railroad rails or beams.

New 34 Story Union Central Bldg.

Tallest Skyscraper in the World outside of New York City.

Home of Cincinnati Chamber of Commerce.

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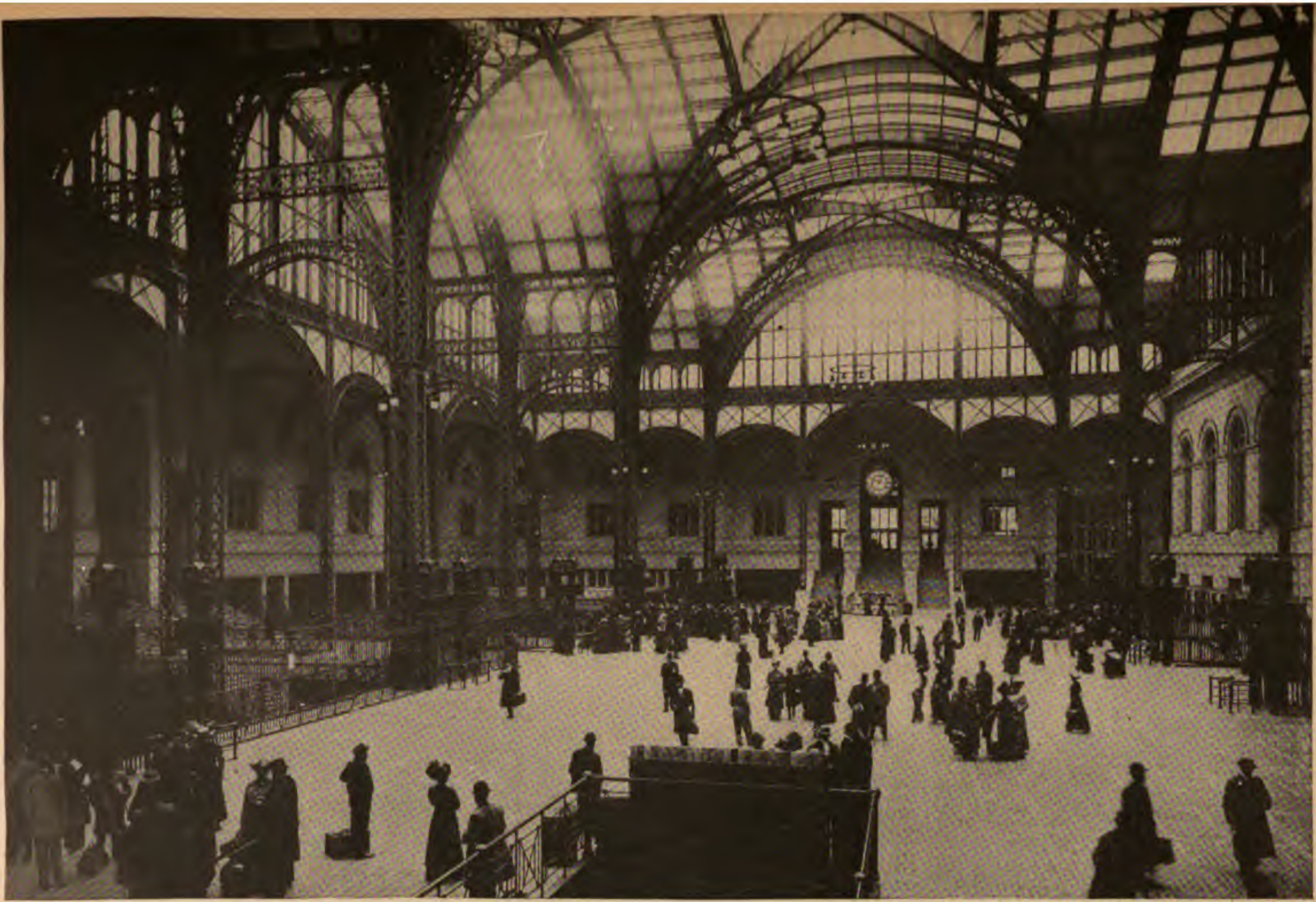
First a bed of concrete is laid, and on this is placed a layer of rails or beams set side by side. On this bottom layer another layer of rails or beams is laid, crossing the lower members of the foundation at right angles. On top of the rails a cast-iron plate is laid. This is the shoe for the steel column.

THE COLUMNS.

The column is always made of wrought steel shapes and it is of uniform size for each of two stories, diminishing in size as it nears the roof The floor beams are carried on the columns and the entire frame work is riveted together with hot rivets, just as a bridge is. Architectural engineers say that if it were possible to upset a building of the "Chicago-construction" kind, the whole structure would tip over like a box and would not fall into pieces as a solid-masonry building would. An earthquake might rattle down some bricks, or loosen some partitions, but, according to claims made by Chicago builders, it would not throw down a Chicago skyscraper.



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THE NEW PENNSYLVANIA RAILROAD STATION, NEW YORK.

The general waiting room here shown is the largest passenger waiting room in the world. The station itself occupies two city blocks, an area of nearly 8 acres. It is built of grey granite. The principal entrance is flanked by Doric columns. The trains arrive and depart through subways.

NEW YORK SKYSCRAPERS

New York is famous for its skyscrapers. It not only has the highest building in the world but the largest office building. Lower Broadway is the principal skyscraper section of the city. The large white building shown in the illustration is the Equitable Life Insurance building. It differs from some skyscrapers in that it is not a tower building. The ground plan is carried up undiminished 36 main stories. Its height is 485 feet. The basement part is three stories deep. At present it is the largest office building in the world. It occupies an entire city block. There are about 40 acres of floor space in the building. The weight of the steel frame work alone is 32,000 tons. It is served by six banks of 8 elevators each in the center of the building, running to the 13, 21, 28, 33, 36 and 38 floors. This means, for instance, that the eight elevators to the 33 floor do not go above that floor. The former Equitable building on this site was burned in 1912. The present building is famous for the rapidity with which it was constructed.

The surroundings are very interesting. Across the street is noticed the spire of Trinity Church. This is a famous church building and the corporation is the richest church society in the world, owning a great deal of real estate. In the cemetery surrounding the church are buried many persons famous in early history. Alexander Hamilton is among the number. Back of the church spire is seen the tower of the Singer Manufacturing Company building, another immense structure, 612 feet high, but it is a tower building and does not cover as much ground as the Equitable.

Right this side of the Equitable building, as you look at the illustration across from Trinity Church, is Wall street, extending east to the river. It is not a very wide nor a very long street, but it is the financial center of the United States and will probably hold that place in the world's finances before long. The United States sub-treasury is located on that street and a great many very rich and powerful banks, like that of J. P. Morgan Co. are located there. Its name, by the way, is a reminder of early days. It occupies the site of a stone wall that once extended across Manhattan Island. The Metropolitan Life Insurance Building, 700 feet—fifty stories high, is also situated on Broadway.

In a building like the Equitable 10,000 tenants can find accommodation. On reflection we see that building has population sufficient for a large town. A good many thousand people must visit it every business day. The elevator service is what makes these immense buildings possible. Offices on the 30th floor would be useless were it not possible to reach them in commodious, easy and swift running elevators. Elevators in such buildings move at the rate of 700 feet a minute, hence an office on the 30th floor is readily accessible. There are some objections to these immense buildings. They shut out so much light and sunshine that the streets and lower floors are not desirable locations. Further, suppose Broadway were lined with such buildings full of tenants, in case of a sudden panic—from fire or other cause, the streets would be simply choked with people. There is a strong movement in cities to limit the height of buildings and some cities—Boston for instance—have such regulations.

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LOWER BROADWAY, NEW YORK CITY.

FIREPROOFING.

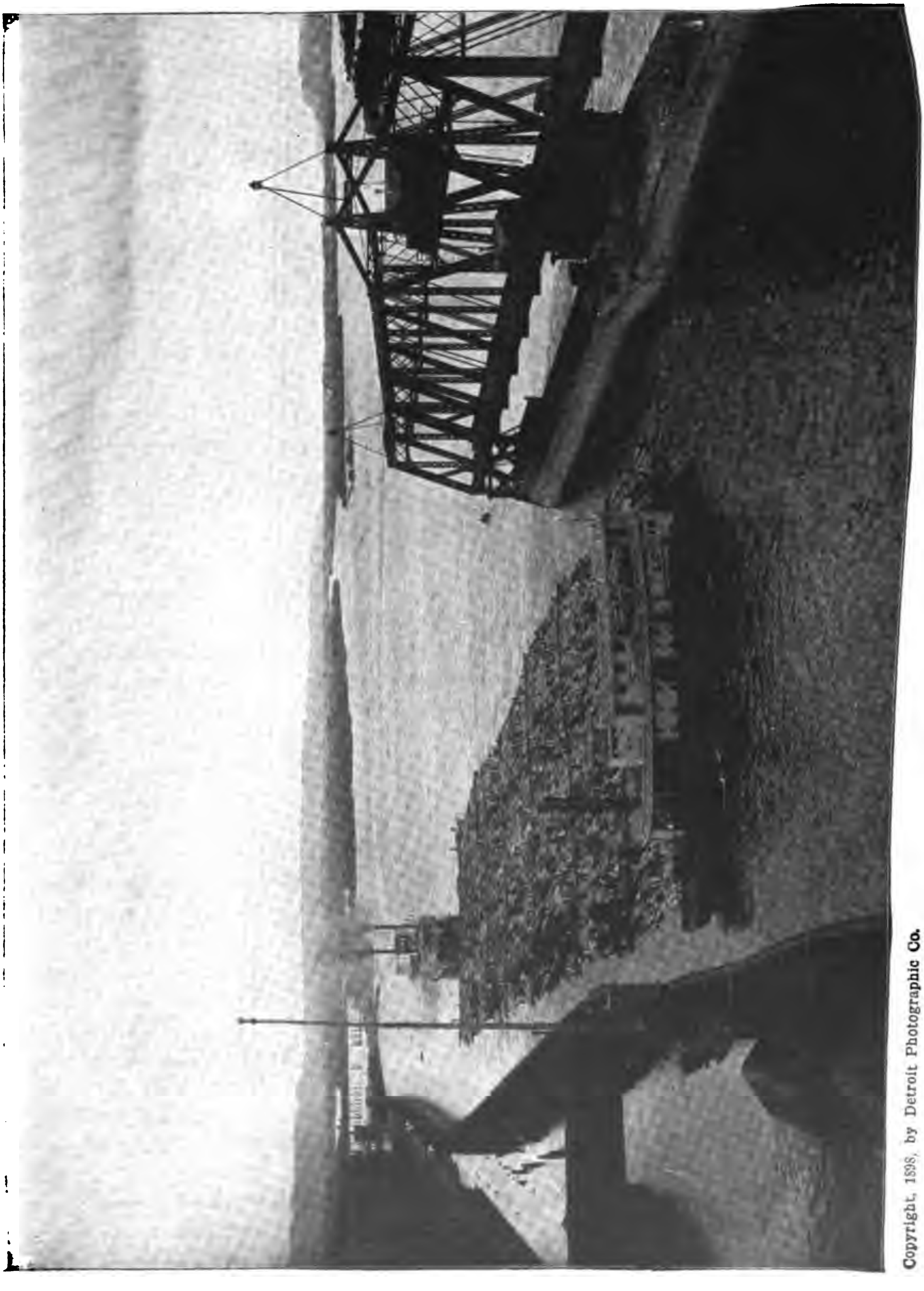
Every piece of exposed steel work is completely surrounded with some fireproof material, such as blocks of tile, terra cotta or brick, and air spaces are left between the fireproofing material and the metal, for dead air is one of the poorest conductors of heat known. The hollow tile arches, placed between floor beams, are covered over with thick concrete, and this concrete is fireproof. The partitions are of hollow tile, which is not only light as compared with brick, but is fireproof as well; and it is said that buildings of "Chicago construction" are as nearly fireproof as it is possible to make them. The average thickness of the walls of a modern skyscraper runs from 16 to 18 inches, the walls carrying about the same thickness from the ground up. This is a radical departure from the old-fashioned construction, for the walls of the lower floors of 15 stories of solid masonry would have to be at least three and a half feet thick, and would drop off about four inches for every two floors above the third. This thinness of walls in Chicago buildings has its disadvantages from the point of view of the architect, for it gives a "skimpy" look to the building, but to the ordinary man they are simply wonders.

THE TIMBER INDUSTRY

The timber industry in the United States is a very important one. This is what we would expect when we begin to reflect on the many uses to which timber is put. Wood is by far the principal material used in building, and in 1918 some over forty billion feet of lumber, board measure, was produced. That is an inconceivable amount. With it one could build a walk thirty-three and a third feet in width around the world at the equator. Our railroad mileage is very large and no good substitute has yet been found for wood for ties. In 1918, 150,000,000 ties were produced. The far larger part of all the paper used in our country is made from wood, and it requires over four billion cords of wood for such purposes.

These are only a few of the principal uses for wood. In the last census year there were 40,671 establishments such as logging camps, sawmills, etc., giving employment to almost seven hundred thousand men, and the value of their output was the immense sum of $1,156,128,747.

Considering the fact that an area of about 7,000 square miles of forest must be cleared to supply the yearly demand for board lumber alone, we can see what great drafts are being made in our forest reserves. Nature requires many years to bring forest growth to maturity, so all can see the danger of exhausing the timber of our country. As everyone knows, the immense pine forests of Michigan, Wisconsin and Minnesota are nearing exhaustion; the same fate seems in store for the yellow pine forests of the South. It is also a matter of common knowledge that deforesting a country is followed by serious changes in climate and rainfall. Consequently all governments have of late years turned their attention to the conservation of their forests. Science has shown that our forest supplies are probably sufficient for our needs, provided care is exercised in cutting the timber and saving the young trees. We are learning also how to reforest areas already denuded of forest growth.



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RAFTING SAW LOGS THROUGH A DRAWBRIDGE—UPPER MISSISSIPPI

NATIONAL FORESTS.

To further these ends the United States government has withdrawn large sections of forest growth from private ownership, and has assumed control and care of them. For this purpose the Department of Agriculture has organized the Bureau of Forestry, and this has become one of the principal bureaus of that department. There are at present 152 national forests in the United States, having a total area of 243,438 square miles. This is nearly as large an area as Texas. In California, alone, there are 19,188,091 acres of national forests. The largest single forest, however, is the Datil Forest in New Mexico, 2,955,000 acres.

A LOG RAILWAY OVER THE MOUNTAINS OPERATED BY A STEEL CABLE AND WINDING DRUMS.

These forests are under the care of the chief forester, and a large force of sub-foresters, rangers, etc. Timber is allowed to be cut under their direction and a large number of animals are allowed to be pastured. In 1918, 840,612,000 feet of lumber were cut from these forests. The total revenue from them for all purposes was $3,457,028. Many separate states are following the lead of the general government in this matter, and thus our forests are being conserved, but still their destruction continues at an alarming rate.

The loss by fire in our national forests is very great. In one year there were over forty-five hundred fires, entailing a loss estimated at $192,000. California was the greatest sufferer in this respect. A long and severe drought was followed by a general and severe electrical storm, which occasioned over 700 fires at once. In all, 1,571 forest fires were occasioned by lightning, but during the year a great many forest fires were of an incendiary nature. It requires the services of a large force to properly protect the forest, but the efficiency of their work is such that 50 per cent of the fires were extinguished with but a small loss.

In timber produced the state of Washington is far in the lead, New York second, and Michigan third. Eleven states reported a value of products of over $40,000,000 each. The sawmills are located near the forests. In these mills modern machinery of the most advanced type is employed. In getting the logs to the mills, and moving the finished product from the mill to the railroad, traction engines and temporary roads are employed.

Like small streams running to a great river, the traction engine lines of the California logging districts feed the railroads. Next to the Puget Sound country the mountains of the Coast Range and the Sierra Nevada in Northern California furnish the most extensive logging industries west of the Missouri River. These vast forests contain redwood, yellow and sugar pine, cedar, fir and tamarack. The lumber is shipped east and exported to Mexico, Panama, the Central and South American ports, Sandwich Islands, China, Japan, Australia and even Europe.

In the movement of logs to the mill and lumber to the railroad, traction engines have replaced horses, mules and oxen almost entirely. A few teams are used to get the logs out to the wagon road, but much of this work is now done with donkey engines and wire ropes. It is no longer necessary to locate the mill on the railroad, for it can be erected in the woods and the lumber hauled on traction trains over any wagon road where teams can draw a load. It is much cheaper and quicker to build a good wagon road and equip with traction engines and wide-tired log wagons than to build the logging railway formerly employed, and when the district is cut over there is no track to take up and move. The size of the loads which can be drawn and the grades climbed is surprising.

HAULING LUMBER FROM MILL TO RAILROAD.

BRINGING BIG LOGS TO THE MILL.

STATISTICS OF MANUFACTURING INDUSTRY.

It is not possible to give in detail each important line of manufacturing in the United States. All branches of manufacture have been rapidly growing, and at present are increasing very fast. The last statistics obtainable show that 22,000,000 human beings, or nearly one-quarter of our entire population, depend directly for their livelihood on the manufacturing industries of the United States. This includes the 9,000,000 employees of the various establishments and the members of their families. The total investment in the industrial plants of this country is $24,000,000,000 and their normal yearly output aggregates $28,000,000,000. This production is over twice that of the country ranking next in industrial activity. It exceeds largely the amount of the manufactures of Great Britain and Germany combined, and is worth more than the annual agricultural yield of the United States or Russia. The manufacturing interest is thus seen to be of stupendous importance in our national life.

QUESTIONS ON THE TRANSPORTATION INDUSTRY.

What new forms of transportation activity can you name?

Do you think they will ever be complete with railway and steamship as freight carriers?

But they are competing in one line of freight, what is it? Do you think they will ever compete as passenger carriers? Reasons for or against.

What can you say about motor trucks as means of transport?

Mention some respect in which electricity is replacing steam as a transport power.

What was the first railroad in the United States?

Mention one transcontinental line. Do they have railroads in South America? Africa?

Mention some important railroad tunnel in the United States.

Where is the Simplon tunnel?

Do they have any railroads in Alaska? What company is building it?

Can they telegraph to a moving train?

What is a railophone?

What is the fastest electric car you know about?

In "Electricity" we read that one train going down grade could help another a hundred miles away if provided with electric locomotives, up grade, how is that possible?

Explain the monorail system?

Where are elevated roads used?

What is a subway in a city?

Which is the more numerous on the ocean, sail vessels or steam-using vessels?

What is a whaleback?

Mention one reason for our enormous Lake commerce.

What canal between Lake Superior and Lake Huron?

What important straits would a steamer from Chicago to Buffalo utilize?

What is the grain fleet on the lakes?

Mention a very important canal in the United States?

What do you mean by "Canalization" of rivers?

Mention two great ship canals.

What are locks on canals?

Where is the Panama Canal? In what direction does it extend?

Considering ship canals, which has been more important in the history of commerce, canals or railroads? Your reason.

Which has had the greater influence on civilization, transportation or applications of electricity? Make a list of the advantages of both.

You have reviewed many inventions, how many of them were of value in transportation? Mention them.

The dissemination of thought is a form of transportation, how does electricity help in this matter?

Bees and insects transport something absolutely necessary to plants, explain this statement.

If this be true, which is of more importance to man, bees and insects, or railroads?

QUESTIONS ON THE AGRICULTURAL INDUSTRY.

About what amount is the capital invested in agriculture in the United States?

About what is the value of all agricultural products in the United States per year?

What do you mean by "Agricultural Eugenics"?

Mention some of the irrigation projects of the government.

Consult the pages telling you about our government and tell us what department has charge of such projects.

What is forestry? What department of government attends to it?

Describe the activities of our Department of Agriculture.

Where is the world's greatest meat market?

How does the government guard the interests of the public health in the packing industry?

What department of government attends to this work?

Mention some interesting facts about the Chicago packing houses, such as size and products.

What are "Kosher" cattle?

What is meant by "candling" eggs?

What species of fish is canned very extensively? Where are they caught?

Mention some of the uses of corn.

What is meant by improved corn? What boys club is helping in such work?

Mr. Burbank made experiments with the ancestor of all corn, what was that ancestor?

What do you mean by new breeds of wheat?

Do you think of any reason to conclude that the yield of corn and wheat can be greatly increased?

What are some of the means to accomplish such a result?

Where is one of the greatest wheat markets in the United States?

Describe a modern grain elevator.

Which, think you, is the most important crop, corn, wheat or cotton?

What is a cotton compress?

What is cotton seed good for?

What is it to gin cotton?

Why is cotton made a contraband of war?

What vegetable is utilized in making sugar? What plant? What tree?

Do all these grow in the same section? Which one in New England? In the West? In the South?

What are some of the tobacco products?

Do they raise olives in the United States?

In what part of the United States is the dairy industry prominent?

Mention some fruit sections of the United States.

Where do we raise oranges?

Where are vineyards prominent?

Do we raise bananas in any state?

Mention some of Mr. Burbank's improved fruits. What is a plum-cot? A citrange? A pomato?

Mention some varieties of nuts raised in the United States?

Do we raise cocoanuts in the United States?

What is the average sized farm in the United States?

Where is the average farm the largest in size? Where the smallest?

Where is the largest farm?

What invention, now coming into vogue, is assisting the farmer?

Which produces products of the greatest value—agriculture or mining?

Could agriculture be prosperous if we did not have a good transportation system?

QUESTIONS ON THE MINING INDUSTRY.

Describe the relation between the mining industry and transportation industry?

What has coal had to do with civilization?

Will we probably exhaust our coal supplies? Give figures for your conclusion.

What country has the greatest known supply of coal?

How many kinds of coal are there?

What is anthracite coal? Where found?

What is bituminous coal? Where found?

What is coke? Where is the center of the coking industry? Any coking coal in the South?

What electrical invention saves valuable by-products in coke making?

Describe mining coal as far as you can.

What are breaker boys?

In "Electricity" we considered a way of greatly increasing the energy from coal, what was it?

What is "white coal"?

Which is more important iron or coal?

Would either one be of use without the other? If you had to give up one, which would it be? Your reasons.

Where are the richest iron deposits in the United States?

They mine coal and it is ready for use, can they mine iron that is ready for use?

If we did not possess a splendid system of transportation, would our coal and iron mines be of great value?

Which, think you, is the more important, the mining or transportation industry? Your reasons.

Since coal and iron must some way be brought together, which is the better way to carry iron to the coal or coal to the iron? Why?

What kind of iron is "pig" iron? Why did it receive that name?

Is electricity ever used in making iron?

What is it to "roll" steel?

What is the difference between steel and iron?

How did Lake Superior iron ores help win the war?

How do they mine for salt?

In what way did the oil wells of our country help win the war?

Do you see any relation between natural gas, petroleum and coal?

If so state it in full.

What is the difference between natural gas and manufactured gas?

In what way did the oil wells of our country help win the war?

We have in the United States such minerals as gold, silver, and copper; also such non-minerals as coal, oil, and gas; which group contributes most to the wealth of our country?

BOOK III

INTERESTING FACTS ABOUT GREAT NATIONS

Our Country and Its Matchless Development. Impressive Details of National Greatness and Eloquent Description of Natural Wonders. A Graphic and Vivid Account of National Life in All Lands.

THE WHITE HOUSE.

Official residence of the President.

INTERESTING FACTS ABOUT GREAT NATIONS

THE UNITED STATES

It is proper to begin our account of different nations with an array of facts concerning the United States, for this is our native land. Many thousands of foreign birth have made it the land of their adoption, and have enrolled themselves as citizens, cast their lot with us, and their children will be native-born Americans. And so to virtually all, the flag of the United States is our flag, to this country our allegiance is due.

It is simple justice to take pride in our country's greatness. In area, in population, in all the factors of material greatness there is surely none that surpass us in the total sum of their resources. Let us, therefore, learn some of the great facts concerning our country, and as we pass them in review let us reflect that real greatness in nations, as in individuals, depends on something more than material prosperity.

AREA OF THE UNITED STATES PROPER.

The area of the United States proper, not including Alaska or our island possessions, is 3,026,789 square miles. In location, it extends from ocean to ocean and from the Lake of the Woods on the north to the mouth of the Rio Grande on the south. The geographical center of this territory is in Smith county, Kansas. The name—United States—signifies the close and indissoluble union of 48 self-governed states, the largest single one of which is Texas, with a land area of 262,398 square miles; the smallest state is Rhode Island, with 1,067 square miles of land. The Mississippi River flowing north and south divides the area of the United States into two unequal portions. To the west of the river are 22 states, with a combined area of 2,145,313 square miles, thus possessing an average area per state of 97,313 square miles of land and water. Of these, the largest, excepting, of course, Texas, is California, with an area of 158,297 square miles. To the east of that river are 26 states (not including the District of Columbia), with a combined area of 771,476 square miles, an average of 33,903 square miles per state.

COMPARISON WITH OTHER COUNTRIES.

Only by comparison can the immense area of our country be properly appreciated. Fifteen Germanies could be carved out of our territory, or thirty-one Italies, or yet again sixty states as large as England and Wales. If we unite in one Great Britain and Ireland, France, Germany, Austria and Italy and then for good measure add Spain, Portugal, Switzerland, Denmark and Greece, and then multiply this combined area by three, we could place it all in the United States, west of the Hudson River. Austria, Germany, France, Italy and Spain could be placed east of the Mississippi, but including Louisiana west. Great Britain, European Turkey, Switzerland, Denmark, Portugal and Palestine could all be located in Texas. Belgium, Holland and Greece would be comfortable in Arkansas, while Japan, China proper, Norway and Sweden would find room in the remaining territory west of the Mississippi.

GROWTH OF UNITED STATES IN AREA.

That part of Continental United States east of the Mississippi River and north of the east and west boundary line between Louisiana and Mississippi is the territory ceded to the United States at the close of the Revolutionary war. Speaking generally, that part west of the Mississippi River, except Texas, extending west to the Rocky Mountains, came to us by purchase from France in 1803. The remaining part east of the Mississippi, including Florida, came to us by purchase from Spain in 1819. Texas came to us by annexation, as an independent republic, in 1845. All that part west of the Louisiana purchase and west of Texas, as far north as the boundary between California and Oregon, came to us from Mexico by treaty at the close of the Mexican war in 1848. The northwestern part of the United States, including Idaho, Oregon and Washington, in dispute with Great Britain, was definitely relinquished to the United States by treaty in 1846.

POPULATION OF THE UNITED STATES.

The census of 1790 showed a population in the United States, or the small section of country that was then entitled to the name, of 3,929,214. The last census gave a population in our enlarged country of 91,972,266. This shows an average increase in population of 733,692 for every year of the 120 years intervening between the first and last census. As a matter of fact, the absolute rate of increase has rapidly increased of late years. In the decade between the last two censuses the increase was 1,597,767 per year; but in the four years between the last census and 1914 we increased at the rate of 1,869,683 per year.

Further examination of the figures disclose that New York has the greatest population of any single state, it being 9,113,614; Pennsylvania is second, with Illinois third. In each instance the deciding factor is the presence of one of the three largest cities in the United States, New York, Philadelphia and Chicago. The density of population varies between wide limits. The average population per square mile of territory is 30.7. The greatest density is in Rhode Island, 508.5 per square mile, while Nevada has only 0.4 inhabitants per square mile.

COMPARISON WITH OTHER NATIONS.

The United Kingdom, Germany and France have a total area of 537,225 square miles, which, it will be noticed, is just about one-sixth of our area; but their combined population is 149,758,517, which is about one and five-eighths times the total population of the United States. There is evidently room in our country for a great increase in population, making all allowance for arid and mountainous lands in the West. On examination, we discover that the average population per square mile in the three countries named is 260. Were the United States as densely populated, we would be a nation of 750,000,000, a number probably far greater than we will ever possess. However, our agricultural resources are amply sufficient to support several times our present population.

According to the last census, only about half of the area already taken up as farms was improved. Presumably the balance, over four hundred million acres, could be rendered as fully productive as the present improved area. Further, improved methods of agriculture, to which reference has already been made, will easily double the present productivity of all our cultivated land. But even this is not all. There were still remaining immense areas in the so-called arid sections. It is estimated by the geological survey that 120,000,000 acres of that amount can be rendered fertile by irrigation; and it has been demonstrated that irrigated land in the West, on an average, is twice as productive as fertile land in other sections.

THE CENTER OF POPULATION.

The last census showed that the center of population was at Bloomington, Indiana. It has moved steadily west since the first census year. Eventually it will be found far west of the Mississippi. Few realize the vastness of the West. The amount of land east of the Mississippi is only 41 per cent of that west of the river. The average size of the 26 states east of the Mississippi is only 35 per cent of that of the 22 states in the West. There are only three of these 22 states that are as small as the combined area of the six New England states. Montana would stretch from Boston in the east to Cleveland on the west, and extend far enough south to include Richmond, Virginia. If Idaho be placed on the eastern map, its greatest length would extend from Boston to Pamlico Sound, North Carolina, while its northern boundary would reach to near Cleveland. If California were placed along the eastern seaboard it would extend from

ON A WESTERN RANCH.

New York to Savannah. The longest measurement of Texas is nearly as great as the distance from Chicago to Boston.

GROWTH OF THE WEST.

While all sections of our country have developed rapidly in recent decades, yet the West has developed at a relatively more rapid rate. Now, more than half the amount of land in farms is located to the west of the Mississippi and more than half the total value of farm property is also in that section.

As we have seen, the great grazing fields are in the West, and the packing house industry has steadily moved to the west. The centers of activity of other great industries have also been steadily moving west. At present, coal production and iron and steel manufactures are in the East, where they will probably remain. But gold, silver and zinc are produced in the West, and as is known there are large coal, iron and copper deposits in that section. Washington already leads in the timber industry. Our great national forests from which is to come the principal timber supplies of the future are nearly all in the West. The center of the petroleum industry is in the West, as is also that of the beet sugar industry. We must further reflect the East has had a century of development, but excepting California, the western development is the result of the last fifty years. It is in the West that the great railroad development of the future in the United States is to take place; also the greater portion of the immense water power development of the future will be in the West. Even at present, the Sacramento river has developed more water power than any other river in the United States. Taking all these facts into consideration, it does not surprise us that population in the West increased in the last decade 29.9 per cent. while that east of the Mississippi increased only 17.6 per cent.

WHERE THE PEOPLE LIVE.

In the last census year 46.3 per cent of the people in the United States were living in cities and towns. Figures disclosed that we had fifty cities each over 100,000 in population. Of these New York, with 4,766,883, was the largest; Chicago, 2,185,283, was second, and Philadelphia, 1,549,000, was third in rank. There were 179 cities between 25,000 and 100,000 in population, and 2,173 exceeded 2,500 in population. Nothing below that figure was considered a city.

FOREIGN BORN.

In the last census year the white, foreign born population in the United States was 13,345,545. The principal nationalities represented among these people were Great Britain, including Ireland, 2,573,123; Germany, 2,501,181, and Russia, 1,602,752. In early centuries Europe was settled by successive waves of emigrating people, coming with their flocks and herds from Western Asia. Nations themselves have not been on the march within the last century, but there has been a continuous stream of emigrants from the Old to the New World and principally to our country, attracted by our vast natural resources and our free and stable government. The volume of emigration to this country for the four years, 1911-14, inclusive, averaged over 2,800 a day, including Sundays, holidays and even the leap year day of 1912. In 1914 alone, 1,218,480 emigrants arrived at our ports. They came from all sections, very largely, however, from the Mediterranean countries. The character of emigration during recent years is not as high as earlier emigration from Northern Europe, and there is a general demand that the government take steps to exclude really undesirable elements.

WEALTH OF THE UNITED STATES.

Considering our area, resources and population, it does not surprise us to learn that we are the wealthiest nation in the world, but how greatly we exceed any other nation is realized by but few. The latest estimate of our wealth is $250,000,000,000. Those words fall lightly from our lips, they are beyond our capacity to understand. We might say that were a twenty dollar gold piece to be coined every second, day and night, without ceasing, it would require 395 years to coin pieces to that value. For the sake of comparison, we might add that our wealth is one fifth more than the combined wealth of Great Britain, France, Italy, and Japan. We are owing about twenty billion dollars, but various nations in Europe owe us nearly half that amount, which was loaned to them in times of need. Not considering those sums, our total debt is only about eight per cent of our wealth. The combined debts of the nations just mentioned, represent nearly thirty-three per cent of their combined wealth. Finally let us add that our debt, vast as it is, is only about one-third of our national income for one year. There is not another nation in the world that can present such a balance sheet.

INCREASE IN WEALTH.

Not only is our country the richest one in the world, but its wealth is increasing at a startling rate. It increased four-fold in the last thirty years. But we have seen in the review of our mining, agricultural and manufacturing industries that great as they are, as rapid as has been their development of recent years, they are all growing with great rapidity at present. The only limit to such expansion is the world's demands. The mineral wealth we now produce approaches $3,501,839,401 yearly. The value of our farm products in 1918 was $19,433,849,000, while manufacturing adds about $10,000,000,000 to the value of the raw materials on which it works. These three industries are the only real sources of wealth in the world; and not only is our production in each of these departments far greater than that of any other nation, but it is rapidly increasing. The agricultural products of 1918 showed 142 per cent increase in value over that of the last census year, while the manufacturing industry showed an increase of over 50 per cent. The wealth of the United States in the next census will equal the combined wealth of Europe.

OTHER ELEMENTS OF NATIONAL GREATNESS.

We have been considering only the contiguous, compact portion of the United States. Only a few nations surpass us in this respect; Russia, Brazil and Canada may be cited. But not one of these is so well situated in all respects. Our territory is unified by railways. Our mileage of 265,000 equals the combined mileage of Europe and South America. Our river systems and Great Lakes afford a medium of inland water communication that is unexcelled. East of the Rocky Mountains we have a river flow of 40,000 miles, counting no stream of less than 100 miles in length. Europe has but 17,000 miles of river flow. The Mississippi and its tributaries afford

35,000 miles of inland navigation. Only the Amazon and its tributaries can equal these figures; and that great river for thousands of miles traverses what is at present a tropical jungle. The 3,900 miles that a steamboat can ascend the Mississippi and Missouri rivers traverse one of the most fertile agricultural sections in the world.

in Central Africa. What these lakes mean to the United States, as affording cheap water transportation for the grain, lumber and ore of the Northwest to the manufacturing East is shown by the fact that the commerce utilizing the Soo Canal is about twice as great as the world's commerce passing through Suez.

NEW YORK AND BROOKLYN BRIDGE.

THE GREAT LAKES.

Excepting Lake Michigan, wholly within United States territory, we share the Great Lakes with our northern neighbor, Canada. The area of these lakes is greater than that of Great Britain and Ireland combined. Here is to be found nearly one-half of all the fresh water on the globe. The only other lakes at all comparable with them are those

OUR INLAND COMMERCE.

The inland domestic commerce of the United States is vastly greater than that of any other nation in the world. It aggregates many billions of dollars yearly. Our population of about 110,000,000 is consuming more and more the immense volume of mineral, agricultural and manufactured products. In this respect, also, the United

States possesses advantages beyond comparison with those of any other nation in the world. In our extended area are located forty-eight independent nations, so to speak, indissolubly united, enjoying perfect freedom of intercourse, with but one language and one currency, with common interests and common institutions.

OUR EXTENDED COAST LINE.

The ocean going commerce of a country depends on the possession of sea ports, and no country in the world has such a multitude of fine harbors as the United States. Our vast coast line along the Atlantic is deeply indented with numerous bays, furnishing commodious land locked harbors where the navies of the world can find anchorage. This extended coast line, and these harbors render possible the immense ocean going commerce to and from our shores. One of these ports, that of New York, is now the most important seaport in the world. In 1918 there arrived at New York 12,913,000 tons of ocean freight, and more than that amount cleared for foreign ports. Our Pacific coast line is not so well provided with commodious harbors, but some of the finest in the world are located there. The coming great commerce of the Pacific, destined to greatly surpass that of the Atlantic, will find ample accommodation in the Pacific ports.

CONCLUSION.

We have passed in review some great facts pertaining to the material greatness of our country. The list could be greatly extended, but enough has been mentioned to show the wealth, greatness and unsurpassed advantages possessed by the United States as a nation. Our past is a record of the most marvelous advance ever made by a nation in the same length of time, and it prophesies a future advance more wonderful than any ever dreamed. It is the privilege of every American and every foreigner who has cast his lot with us, to rejoice in these splendid facts. But we should tremble as well as rejoice. Wealth and power are always accompanied by grave dangers from within and from without. Other nations, rich and powerful, have arisen, flourished and fallen. Egypt, Babylon and Rome were each relatively as great as the United States is and seems destined to be. Our country will escape similar fate only as its citizens are actuated by patriotism in its widest and truest sense, and recognize the world-wide claims of justice, morality and brotherhood.

OUTLYING POSSESSIONS OF THE UNITED STATES

In addition to the compact, contiguous area we have thus far considered, the United States has acquired possession of other sections aggregating 716,518 square miles, reporting a population of over nine million in the last census year. The total area thus added to the United States is as large as that part of the United States east of the Mississippi river, excepting New England and the middle states, New Jersey and Pennsylvania. By comparison with European countries, it is as large as the combined areas of England, Wales, France, Germany and Austria-Hungary. These possessions are scattered from the Philippines on the west, to Porto Rico on the east; from Alaska on the north to the Canal Zone on the south. A brief review will be of interest.

ALASKA

Alaska is eight times as large as all New England. It has a coast line of 26,000 miles. It has the best yellow cedar in the world. It has the greatest salmon fisheries. It has cod banks that excel those of Newfoundland. It has one of the largest rivers in the world.

THE YUKON RIVER.

The Yukon is 20 miles wide, 700 miles from its mouth. With its tributaries, it is navigable for 2,500 miles. It discharges one-third more water than the Mississippi.

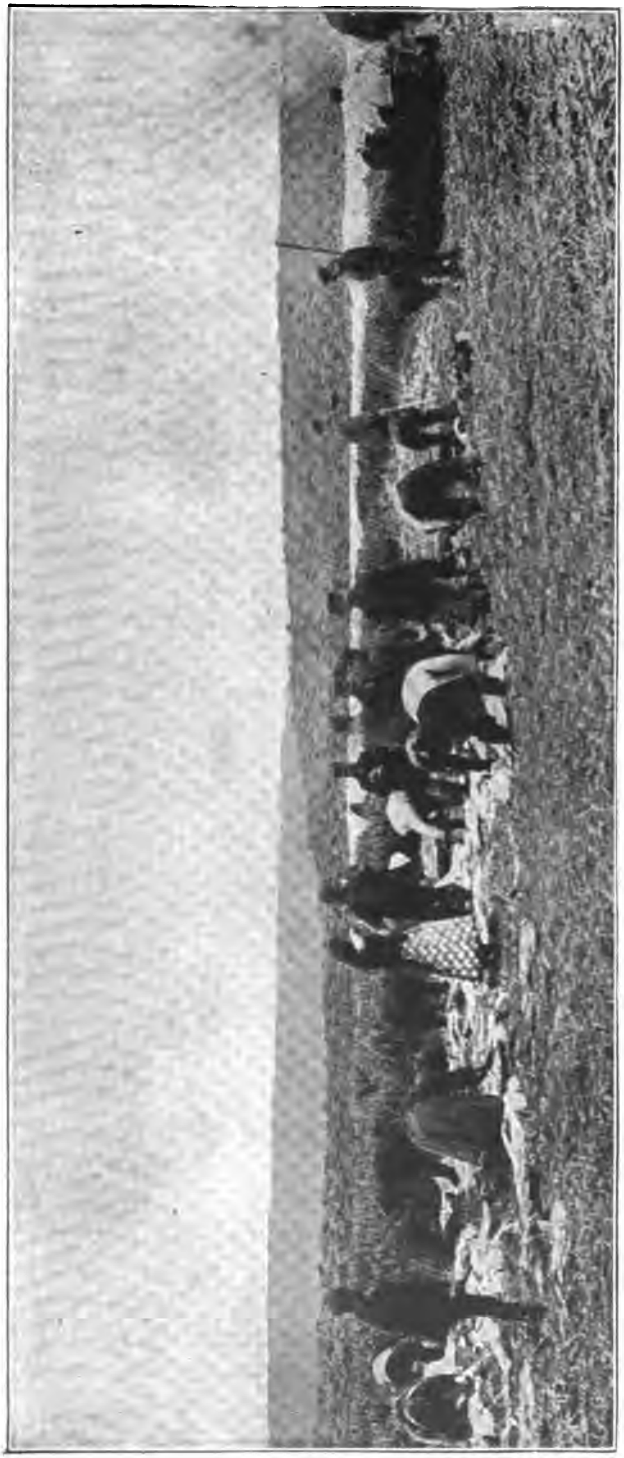
By courtesy of the Detroit Photographic Co.
STAGE COACHES STARTING FOR THE MINES.

VAST EXTENT OF ALASKA.

The territory of Alaska has an area of 329,529,000 acres, of which 272,000,000 acres lie within the temperate zone. In 1867, the United States Government paid for this area $7,200,000. One Alaska company alone has paid to the United States Government $7,000,000 in rentals and royalties. The value of Alaska fisheries in 1918 was over $27,000,000.

TRADE OF ALASKA.

The experience of the world shows greater trade in the temperate zone than in the tropics. Annual exports to Alaska amount to $625 per head. Annual imports from Alaska amount to $400 to $1,000 per head. Alaska is the American Sweden and Norway. It begins in a line within Southern England. Alaska does not extend as far north as Northern Norway. It is richer than Sweden and Norway.



KILLING, SKINNING AND CUTTING UP SEAL IN ALASKA.

THE ISLAND OF KADIAK.

Kadiak, on the coast, is in the same latitude as Aberdeen, Scotland. The lowest temperature ever recorded at Kadiak was five degrees above zero. The average winter temperature at Kadiak is higher than at Washington, D. C.

TEMPERATURE AND PRODUCTS.

The lowest temperature ever recorded at Dutch Harbor, Alaska, was nine degrees above zero. Dutch Harbor is in the latitude of Liverpool. Sitka has not cold weather enough in winter to supply ice for the summer. Alaska is rich in minerals, lumber, fisheries, furs and coal. The trade with Alaska is now nearly twice as great as with Hawaii.

SEAL AND WALRUS HUNTING.

Quite as much trouble has been caused between the United States and British governments over the indiscriminate hunting of seals in Alaskan territory as over any international question. One of the first laws enacted by this government after its purchase of Alaska from Russia, for $7,200,000, was aimed to prevent the slaughter of mink, marten and fur seal in that territory.

BREEDING GROUNDS OF THE SEAL.

The breeding grounds of the seal which is of commercial value are principally the Pribilof Islands of St. Paul and St. George.

This land was leased by the Alaska Commission Company for $60,000 a year, and a commission, or royalty, of $2 on every fur seal taken. The company was limited to 100,000 seals a year.

ILLEGAL HUNTING.

This arrangement made by the Treasury Department was considered very favorable until the great movement of settlers west tempted pelagic sealing or hunting for fur seals in the water. So rapidly did the herds of seal begin to diminish that officials were alarmed, and in 1886, the revenue cutter, Corwin, was sent to the territory and three British vessels were seized for illegal hunting. This caused a great uproar, and a demand was made by Great Britain that the Sailors be released. This was done, but the next year, a similar proceeding followed.

JOINT AGREEMENT WITH GREAT BRITAIN.

After much discussion and legislation, a joint high commission was appointed between Great Britain and the United States and the outcome of its work was a proposed set of regulations to protect the seals. These regulations, which were to continue in force until either party violated them, prohibited the killing (except by Indians) of seal within 60 miles of the Pribilof Islands at any time, and anywhere in the North Pacific from May 1 to July 1, of each year. This closed season allowed the seals time to cross from their winter quarters over the ocean to the Pribilof Islands to breed. Explosives and firearms (except shotguns) were prohibited in hunting. This stipulation, however, was not ratified, and the United States government was forced to prevent sealing on the Pribilof Islands except by the North American Commercial Company and to demand papers showing a complete record of every sealskin brought into our ports. This was a hard blow to Canadian interests, and tended to suppress pelagic sealing.

PELAGIC SEALING.

In pelagic sealing, the hunters sail in schooners from our shores to Yokohama and thence bear down upon the animals in the sealing ground. The cry, "Sleepers," is the warning given by the lookout on shipboard that seals are in sight. A boat is lowered, provisioned for five days, and equipped with shotguns and shells. When the seals are espied they are asleep on their backs, with their flippers across their bellies. Stealthily, the hunters slip upon their quarry and shoot them asleep. Great quiet must be preserved until the killing begins, for, although the seals are almost blind, they have an acute hearing. At the Pribilof Islands, the government has built fences to confine the bull seals during breeding seasons.

WALRUS HUNTING BY THE ESKIMOS.

Walrus hunting is carried on in the Arctic seas by the Eskimos and is a very profitable but dangerous enterprise. The method pursued by these little people of the North is to cruise about the sea, and when a walrus is sighted, to lower a whaleboat with about six men in it. Gently they steal upon the unsuspecting walrus, and when they come within about 20 yards of the animal, it is harpooned. The harpoon has a handle attached at one end, and on the sharp end is a movable barb. To the barb is attached a rope, which jerks the barb to a horizontal position when the spear is buried in the animal. This prevents the harpoon from drawing out. Now the walrus is enenraged and tries to break away. It swims with all its might and the natives shoot it with bullets from a Winchester rifle. So thick skinned is the animal that one shot will not suffice, and six or seven are often necessary. All this time it swims strongly. Finally, it can be drawn near enough to the boat to be stabbed with a lance through the heart and lungs. It is then towed to the ship and hoisted on board by means of pulleys. Here it is cut up. These great animals have valuable tusks and blubber, and average about 1,800 pounds each in weight.

PRODUCTIONS.

In parts of the territory agriculture is possible during the brief summer and the government has established experimental stations to determine the best lines of work. One interesting result is the introduction into the territory of reindeers from Siberia. Official reports show there are 82,151 of these animals in Alaska. To save the timber, the government has set aside 26,761,626 acres in forest reserves. In addition to gold, copper, tin and lead exist. As high as 120,850,000 pounds of copper have been produced in one year. Coal is known to exist in enormous quantities. As the expense of building railroads is very great, the United States government has undertaken that work, its first appropriation for that purpose being $40,000,000. We may, therefore, look for development in all lines of industry. In the last census year, there were 152 industrial establishments in the territory, employing over 3,000 workmen.

HAWAII

About 2,000 miles to the southwest of San Francisco, near the geographical center of the Pacific Ocean, is the outlying possession of the United States, now named Hawaii, formerly known as the Sandwich Islands. It is a chain of eight islands which may be crudely described as strung along the diagonal of an ocean-area, which is over 400 miles wide from north to south by over 600 miles long from east to west. The total area of these islands is about 6,449 square miles, thus a little more than half as large as the state of Maryland. Hawaii became a part of the United States by annexation in 1898, being at that time an independent republic. Its location in the center of the Pacific is very important, strategetically, for the commerce of the Pacific is destined to be very important in the near future and Hawaii may be regarded as the eastern key to that ocean, from which, as a naval base, we can defend Alaska on the north, California to the northeast and Panama nearly east. Fully realizing this fact, the United States government is erecting very extensive military works—among the strongest in the world—at Pearl Harbor, near Honolulu.

On one of the islands is located the most famous volcano in the world, Kilauea. The capital of the archipelago is Honolulu, on the Island of Oahu, near the center of the group, with a population of 52,183. The total population of the islands in the last census year was 191,908, and this population is one of the most cosmopolitan in the world. Over half are Asiatics—the greater part being Japanese. This migration is now prohibited. There were then 4,320 farms with an acreage of 2,590,600. The great crop is sugar. In 1918 the sugar crop amounted to

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AVENUE OF PALMS IN HONOLULU.

550,000 tons. Tropical fruits and tobacco are also raised. The total trade between the United States and Hawaii amounted in 1918 to $115,000,000. The government has made extensive forest reserves in Hawaii, amounting to 683,000 acres. The last census showed that the territory possessed 500 manufacturing plants, employed 5,904 workmen and turned out $47,404,000 of products.

THE FUTURE.

Hawaii could easily support several times its present population. The soil in large sections is very fertile; the climate cannot be surpassed. In time, desirable emigrants will be attracted to the islands and development will make Hawaii one of the most desirable sections of the United States. In time, Hawaii may become a state.

GUAM

A little over three thousand miles in a general westerly direction from Honolulu is the island of Guam, a possession of the United States that was ceded to us by Spain in 1898. It contains about 210 square miles, and has a mixed population of 12,517. It is one of the naval stations of the United States, as it possesses a fine harbor and it is only a little over 1,300 miles from the Philippines and the same distance, due south, from Japan. Its productions are those of a tropical island. In 1918 over $80,000 worth of copra, the dried meat of cocoanuts, was exported. The United States government has established an agricultural experimental station and a system of free schools wherein the English language is taught. The children are also taught carpentry and other handiwork. Guam is in telegraphic communication with the outside world by cables, besides there is a wireless station where messages for Manilla are relayed.

THE PHILIPPINES

The extensive archipelago, known as the Philippines, was ceded to the United States by Spain in 1898. Speaking generally, the archipelago is situated between the 120th and 129th degree of east longitude, and between the 4th and 20th degree of north latitude. This locates it 800 miles east of Siam, the China Sea intervening, and about 1,400 miles slightly southwest of Japan, nearly 7,000 miles southwest of San Francisco. Thus the islands constitute the western key to the Pacific. The total number of islands are 3,141, but many are very small. The total area reported by the United States census is 115,026 square miles, but counting in the Sulu Islands to the south, it is estimated at 127,853 square miles. The largest and most important island is Luzon, at the northern end of the archipelago, which has an area of 40,069 square miles, or a territory as large as the state of Ohio. At the south end of the archipelago is Mindanao, 36,292 square miles in area, or a state as large as Indiana. The population was estimated in 1918 at 9,000,000. It is mostly native Malays. but there are some tribes of Negritos. There are about 25,000 Americans and Europeans and 40,000 Chinese, but the latter are now excluded. The principal city, which is also the capital, is Manila, with a population of 234,409 according to the last census.

GOVERNMENT.

The intention is to give the islands complete home rule as soon as they are fitted for it. At present the governor-general of the islands is appointed by the United States. He is assisted in his work by a vice governor, the auditor and deputy auditor, appointed by the president. The legislature of the Philippines is elected by the people of the islands. It consists of two houses There are six executive departments, the heads of which are appointed by the governor general.

EDUCATION.

The United States government has made great efforts to further education in the islands. In 1918 there were 675,998 children in the public schools, which numbered nearly 5000. School attendance is made compulsory. There were 475 American teachers in the principal towns in 1918, and 1391 trained Filipino teachers in the service of the commission. In addition there were 10,500 Filipino teachers in the public schools supported by the small towns. English is taught in all the public schools. Industrial and trade schools have been established and great stress is laid on industrial education. Higher education is provided in a Normal school at Manila, and the University of the Philippines which teaches all the usual university courses.

PRODUCTIONS.

The chief products are rice, copra, hemp, sugar and tobacco. But agriculture is yet backward, though rapidly improving. In 1918 the area under cultivation was 6,471,942 acres; and the total value of the crops raised was $90,494,321. The forests, which are very extensive, and very valuable, are under the care of a bureau of forestry, which frames plans and rules for their protection aand working. The mineral wealth of the islands has not yet been developed, but gold, silver, copper and other minerals are known to exist. A period of prosperity seems ahead of the islands. About 1200 ships enter and clear from Manila each year. In 1918 the total movement of ocean freight was 3,097,629 tons. Since America took possession in 1898 about 5,000 miles of good roads have been constructed, about 1,500 miles of railroads built, a postal system has been established, and in the postal savings banks about 30,000 Filipinos have deposited about $1,500,000.

SAMOA

In latitude 5 south, and longitude 170 west is another small island possession of the United States, the island of Tutuila in the Samoan group, and other islands east of the 171st degrees of west longitude. Its location is over 2,000 miles slightly southwest from Honolulu. The principal island, Tutuila, has an area of about 54 square miles. The other islets of the group, Ofu and Oloseya, have an united area of about 25 square miles. The census reports the total population of these islands as 6,100. Tutuila is a pleasant island, mountainous, heavily wooded and fertile. These Samoan islands became a part of our territory in 1900 as the result of a convention entered into between the United States, Great Britain and Germany. Its value is wholly that of a naval station, as the harbor of Pagapago is the best harbor in the group. Honolulu, Guam, and Samoa are the apexes of an enormous triangle in the Pacific, none of whose sides is less than 2,000 miles, so situated that the nation possessing them has a commanding position in that ocean. The chief island product is copra, about 1,500 tons being produced yearly and the natives pay taxes in copra. The trade is much greater than we would expect. The tonnage of the ships calling at Pagopago in 1918 was nearly 70,000 and the import and export movement was $325,000 in value.

PORTO RICO

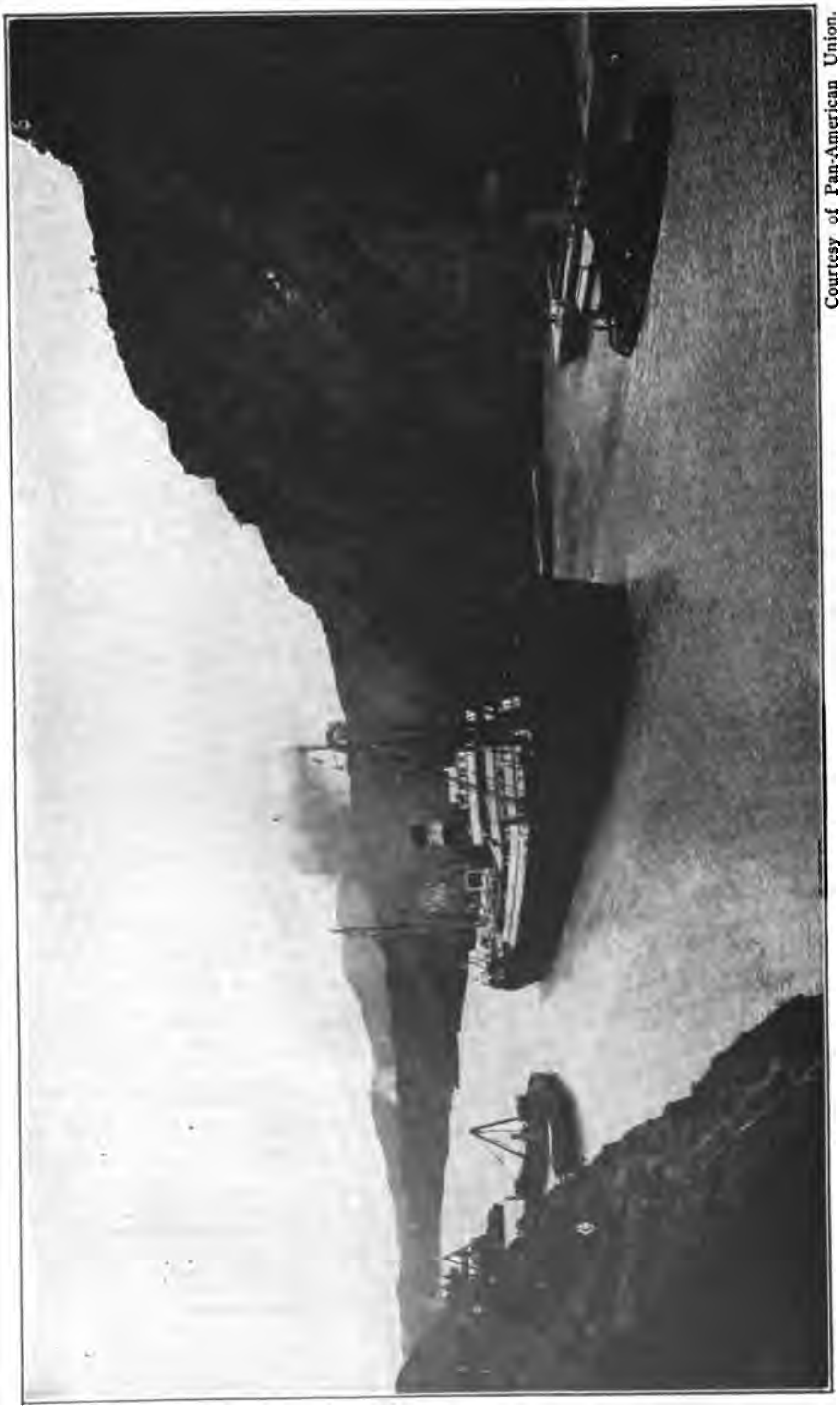
Porto Rico is the island possession of the United States in the West Indies. It is just about 1,300 miles due southeast of Savannah. This possession was ceded to the United States by Spain in 1898 at the close of the Spanish war. Its area is now estimated at 3,606 square miles, or three-fourths as large as the state of Connecticut. The last census gave it a population of 1,118,012. It will be noticed its population per square mile is very high, being 318. Only three states in the Union—Rhode Island, Massachusetts, and New Jersey—surpass these figures. About one-half of this population was white. The chief industries of the island are agriculture, fishing and mining. But the census reports 939 industrial establishments, employing 18,122 persons, and the value of their output was $36,749,742.

INDUSTRIES.

The agricultural industry is well developed. In the last census there were reported 1,570,304 acres of improved land. The chief products are sugar, tobacco, and tropical fruits. In 1918 500,983 tons of sugar were exported. Coffee is a rapidly increasing product, 39,615,146 pounds being exported in 1918. Immense quantities of cigars, cigarettes and leaf tobacco were also exported. The value of the oranges, pineapples, grape fruits and cocoanuts exported the same year was $3,444,158.

RECENT ADVANCE.

As is the case of our other possessions, the United States government has done a great deal to increase the prosperity of the island. In 1899 over 83 per cent of the population could neither read nor write. Now, education is compulsory. In 1918 there were 1,666 common schools, 19 high schools and a well distributed system of night schools and kindergartens, and 115,000 pupils were enrolled. The University of Porto Rico, near San Juan, is equipped to teach all courses usually taught in schools of higher education. Agriculture is made a specialty. Its farm and dairy is equipped with the most recent machinery and improved stock and in connection with it there is a government experimental station. There were but few good roads and no railroads; now there are 1,000 miles of good roads and 220 miles of railroads. The government is spending $3,000,000 on an irrigating system, which will enormously increase the agricultural output of the island.



THE COMPLETED PANAMA CANAL.
Gold Hill on the right—Gailard Cut.

Courtesy of Pan-American Union.

In 1918, 1905 vessels with a tonnage of 5,169,355 cleared from Porto Rico for the United States. That city is the capital, located on the northern short of the island. It has a population og 48,710. The town of Ponce, on the south shore is, however, a larger city, having a population of 63,444.

ADJACENT ISLANDS.

There are three adjacent islands that also belong to the United States. Two of them are of some importance. Thirteen miles to the east of Porto Rico is the island of Vilgues. Its area is a little over 100 square miles, but it is fertile and supports a population of 10,000. Twenty miles to the east is Culebra. This is of importance, because it possesses a good harbor and is utilized by the government for a naval station. On examining an atlas, it will be seen that Porto Rico occupies a strong position, strategically, in the West Indies. It is the eastern key to the Caribbean Sea. In a brief time, owing to the Panama Canal, the commerce on that sea will be enormously increased. All European commerce seeking that canal will traverse that sea. Hence the vast importance to the United States of a naval base at Porto Rico. Extensive improvements for that purpose are being made.

THE FUTURE.

There is no reason why Porto Rico should not experience a prosperous future. It has an excellent climate, fertile soil, and valuable forests. All metals are represented in its, as yet, undeveloped mines. Its political future is as secure as that of the United States itself. With resources developed, its citizens educated, in telegraphic communication with the outside world, in touch with all nationalities by reason of the vessels which call at its ports, enjoying the blessings of stable government, seemingly the future has much in store for this West Indian possession of the United States.

THE CANAL ZONE.

This recently acquired possession of the United States was purchased from the Republic of Panama in 1903. The amount paid was $10,000,000.00, but we also pay yearly as a ground rent so to speak, $250,000.00. As its area is only about 436 square miles, the above figures represent a large price per square mile, vastly greater than that paid in the Louisiana, Florida, or Alaska purchases. But considering its location and the use made of it, it is well worth the price. In fact its value is beyond culculation. No other equal portions of the world's surface have been the theatre of such a prodigious outpouring of public money. There the United States has constructed a canal that has cost nearly $400,000,000.00. It represents our greatest single asset and our greatest military fortification. In effect, the canal doubles the efficiency of our Navy and we are not surprised that on the shore of that zone some of the strongest fortifications ever constructed are being built, manned by immense guns. The canal occupies the center of the zone, which is ten miles wide, except that it flares out, so to speak, to provide a basis for Lake Gatun, and it contracts at both ocean shores so as to leave out the cities of Colon and Panama, both of which remain under the jurisdiction of the Republic of Panama. The general direction of the zone is slightly east of south across the Isthmus of Panama. The value of the canal zone to the United States will steadily increase with time, because the whole world is entering on an era of commercial expansion and the Panama Canal is to be as a great artery through which an increasing share of the commerce is to flow.

THE VIRGIN ISLANDS.

There were formerly known as the Danish West Indies, purchased from Denmark in 1916, formal possession taken in 1917. The northern two are St. Thomas and St. John, situated fifty miles east of Porto Rico; the third island St. Croix (also called Santa Cruz) is forty miles to the south of the two northern islands. Their value to the United States is in their location. They are in the direct track of vessels to and from Panama and Europe, an excellent harbor at St. Thomas, one of the best in the West Indies. It is land locked almost surrounded by hills close to the water edge. In the center of the surrounding shore is the city of Charlotte Amalie. Its location is beautiful, the buildings located on successively higher terraces. There are dry docks, naval supplies and repair shops for vessels, and in normal times the city is the port of call for thousands of vessels. The principal island, however, is the southern one, St. Croix. It enjoys a fine tropical climate, its surface is level, and soil fertile. It has beautiful roads, groves of palm trees, and extensive sugar plantations.

The total population of the three islands is about 32,000, area from 138 to 142 square miles. Yet owing to the strategical importance of their location the purchase price of the islands was $25,000,000.00. Two-thirds more than we paid for the immense area involved in the Luisiana Purchase, more than four times what we paid for Alaska with its great area and vast mineral wealth. The name, Virgin Islands, is the name bestowed on the Islands by the early explorers.

THE AMAZING RESOURCEFULNESS OF OUR COUNTRY.

The people of the United States discovered their own country when spurred to action by the stern necessities of war. Then it was that we marshalled our resources,—industrial and agricultural, scientific and financial,—and came to the rescue of an imperilled world. In so doing there was displayed such a degree of resourceful strength, such unexpected stores of latent power that we were able to solve world problems on whose solution the continued existence of our own country and of free government over the world generally depended. This result was a revelation to the world as well as ourselves. The world discovered what a nation of 100,000,000 free and progressive people could do when roused to action by a danger that threatened their national existence.

OUR COUNTRY ROUSED TO ACTION.

The time came in the course of the world war when it was necessary for the United States to intervene on the side of the Allies against Germany. Having taken that step it was evident that exertions greater than we had ever made would have to be put forth. Freedom called, we had joined forces with the Allies, defeat meant ruin. It was a realization of this fact that roused the American people. The national response was inspiring. All classes of our citizens were swayed by a common impulse to do with their might whatever there was to be done. Our great agricultural citizenship, other millions engaged on railroads, in factories and mines, financiers and men of affairs, educators and scientists—worked for one common end. What we accomplished is history. In one field of activity after another, we achieved results that the world did not think possible. The hopes of our allies, the fears of our enemies were alike surpassed by performance.

AN INSPIRING MESSAGE TO ALL.

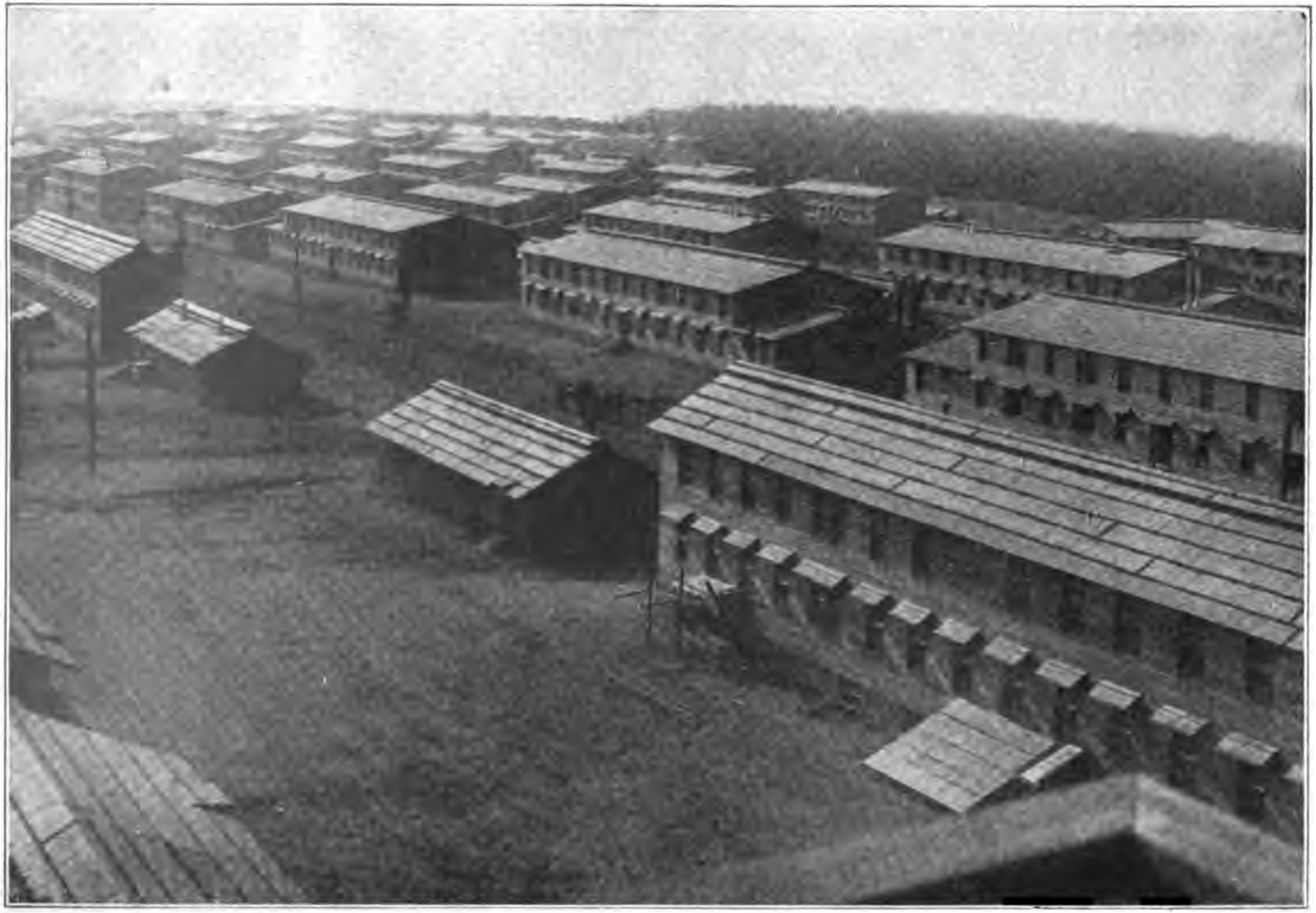
A cursory review of what we as a nation accomplished in those days of strife is of far more than historic interest. There is an inspiring message to you—to all. We have shown a wonderful degree of resourceful strength, we have demonstrated ability to do, to accomplish great things. We must no longer be content with a small per cent of efficiency. An age of wonderfully quickened thought and life and action is upon us. The world is going to need the products of our mines and factories and lands far more than ever before. The nations are drawing together. We must take our full share in the period of greater activity now opening or see more progressive nations pass us in the race. Let us then learn of our activities in certain lines of work that are representative of our country's ability to do when occasions require us to put forth our full strength.

WE BUILD THIRTY-TWO CITIES IN THREE MONTHS' TIME.

A city containing a population numbering between forty and fifty thousand is among the great cities of our land. In three months' time in 1917 we substantially completed thirty-two such cities to serve as cantonments for our hastily mobilized army. The necessity for such construction is evident. It requires far more than mere courage to make an efficient soldier. They must be drilled and fitted for work. Accommodations must be provided for them, and such construction could not wait the leisurely actions of times of peace. This great need was met by the indomitable spirit of American industry, but it was a work of startling magnitude. Probably no other nation could have accomplished such a result in so short a time. It has been summed up as an "unprecedented task, executed in the face of unheard of difficulties, with unrivalled speed and in an unparalleled spirit." It was the triumphant solution of a world problem that had to be met.

THE MAGNITUDE OF THE TASK.

Only by reflection do we realize the magnitude of this accomplishment. The total area of land required for these cities was nearly 200 square miles, the total number of buildings—some of great size—was about 50,000. We provided for a total population of over 1,200,000 people. There are only three cities in the United States equalling or surpassing this population. Let us state it in another way. In three months' time we provided accommodations for a total population only four per cent less than the combined population of New Mexico, Arizona, Nevada, Utah and Idaho as shown in the last census. What other nation could have accomplished such a result? If we had taken twenty-five years in which to do the work it would have been a notable achievement, but the work was substantially completed in three months. Taken singly each of these



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A GENERAL VIEW OF A CANTONMENT.

There were 33 of these cities built in a few months time, in 1917. Each city was planned for a population of about 40,000 people. The total area required was considerably larger than the state of Rhode Island. Nothing more clearly shows the industrial strength of the United States than the erection of these cantonments.

cities provided for a population as large as —let us say—Atlantic City; or Augusta, Georgia; or Lincoln, Nebraska; or Sacramento, California. Enough lumber was provided to have built a board walk, four feet wide, runners and all, from Palm Beach to Bagdad, by way of Bering Strait and the Arctic Circle. To transport needed material, required enough freight cars to form a continuous train from Portland, Maine, to Portland, Oregon, via Boston, Cleveland, Chicago, Minneapolis, and Spokane. In constructing these cities 1,200 miles in length of nails were driven daily. In three months, enough buildings in all were erected to have reached, placed end to end, from New York to Detroit. The following illustrates the speed with which the cities were built, and it is not the least exaggerated. One day, a one story office building, some trenching machines, some teams and trucks, and a chaos of material; in forty-eight hours, a respectable village; in two weeks the village became a town; in two months the town became a city.

OTHER NECESSITIES.

In addition to the buildings, it was necessary to provide in each case an elaborate water system capable of supplying from one to two million cubic feet of water daily. In the aggregate, their construction represents another stupendous achievement. Giant trenching machines were secured, capable of digging a ditch four feet deep and twenty inches wide, up hill and down dale, at the rate of 120 feet an hour. Other machines filled the trenches after the piping was laid. The water was forced into immense tanks, holding 200,000 gallons, from whence it was conveyed through the from forty to fifty miles of piping required for each individual system. In small things also construction needs ran to large figures. Each city required about 350 carloads of cooking ranges and 2,500 carloads of heating stoves. For each, there had to be provided an ice plant capable of making at least twenty tons of ice daily, besides keeping many tons of food chilled to the freezing point. We might naturally conclude that this vast amount of work required the exertion of all our economic strength, but as a matter of fact but a fraction of our ability to do was thus devoted.

BUILDING SHIPS FOR THE WORLD.

In the annals of industry there is no more thrilling account than that descriptive of the enormous development of ship building activity when such construction was urgently needed. Modern civilization depends on ocean going commerce, for that is the principal means that nations have of learning about each other and enable them to exchange their national products. In 1917 nearly one-third the total tonnage of the world had been destroyed by war, and another large fraction was laid up in home ports. The world was suffering for lack of such commerce. In addition, the stern necessities of war made it incumbent on our part that we build with all possible haste a large fleet of commerce carrying ships. It is not out of place to add that all that America holds dear, the welfare of civilization depended on such construction work. We were sending our soldiers to Europe by the millions. To transport and care for them required for that purpose, alone, far more ships than we could command, or that other nations could furnish us. It was a life or death problem; we must build ships, and build them on a scale never before attempted or thought possible, and do the work with far greater speed than ever before considered. Frankly, the world did not think we could meet the great need confronting us. The world did not know the United States.

TRANSFORMING A SWAMP INTO THE LARGEST SHIPBUILDING PLANT IN THE WORLD IN LESS THAN A YEAR'S TIME.

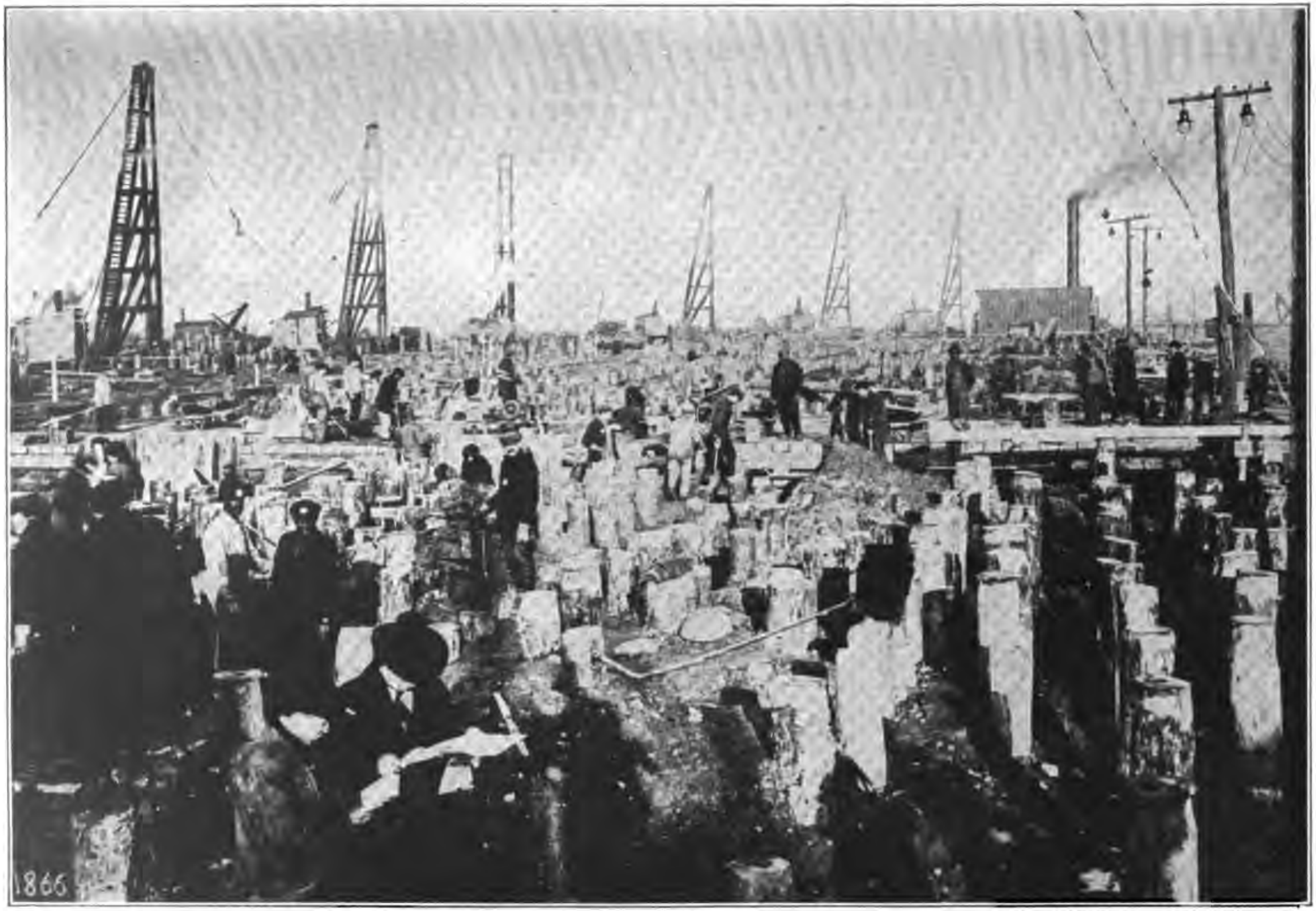
Below Philadelphia, there was a swampy expanse of over eight hundred acres with the significant name of Hog Island. In October, 1917, an immense force of engineers and workmen proceeded to construct on this swampy expanse the largest ship building plant in the world. We could not wait for warm weather and so work proceeded throughout the winter 1917-18. Live steam had to be used to thaw out the ground preparatory to excavation. $35,000,000 were spent in preparation work. But in less than one year's time ships were being launched from that plant. In former years we would have said such a result was impossible. There seems to be no such word as impossible in the dictionary of American industry. In that time we built more than seventy miles of intersecting railroad track in the yards; installed a power plant sufficient to supply the needs of Albany, N. Y., and Richmond, Va., put in a water system with twice the capacity required for a city the size of Atlanta, Ga.; while fifty shipways were strung along a mile and a half of water front, previously a treacherous miry expanse; and there a fleet of one hundred and eighty ships were being constructed. It required 70,000 freight cars to bring needed material for the ships. In reality this was a more startling exhibition of industrial strength than the city building activity just described.

ONLY ONE INSTANCE.

But Hog Island is only one instance. Nearly one hundred and fifty shipyards were erected in that same brief period, up and down our coasts,—the Atlantic, Gulf, and Pacific shores. We can scarcely conceive the immense ship building activity this represents. Not far from Hog Island there were two other enormous plants for fabricated (standardized) ships—the Submarine Boat Corporation and the Bristol Yards, also part of this great activity. These were completed in less than a year and were delivering ships. At Fore River, Massachusetts, a vast program was carried out. At Squantum, a few miles away, the great Victory plant was turning out ships a few months after work was commenced on a frozen, mucky expanse. In twelve months' time the Todd ship yards at Tacoma—a mammoth plant—was erected and was delivering ships where the waters of the Sound had previously ebbed and flowed.

SOME OF THE ALMOST INCREDIBLE RESULTS.

In August, 1917, we had 37 steel and 24 wooden ship yards; one year later we had doubled the number of steel ship yards and increased the number of wooden ship yards five fold. A few months later still, we had 410 completed shipways for steel ships and 63 building; 400 completed wooden, composite and concrete shipways, and 54 under construction. In the single month of August, 1918, the various ship yards constructed 385,000 tons of shipping. The record for the banner year previous was 285,000 tons. Notice, this was 100,000 tons more, in one month, than the total construction for any one previous year. That is a measure of the enormous increase of our ability to do when spurred on by stern necessity. Now



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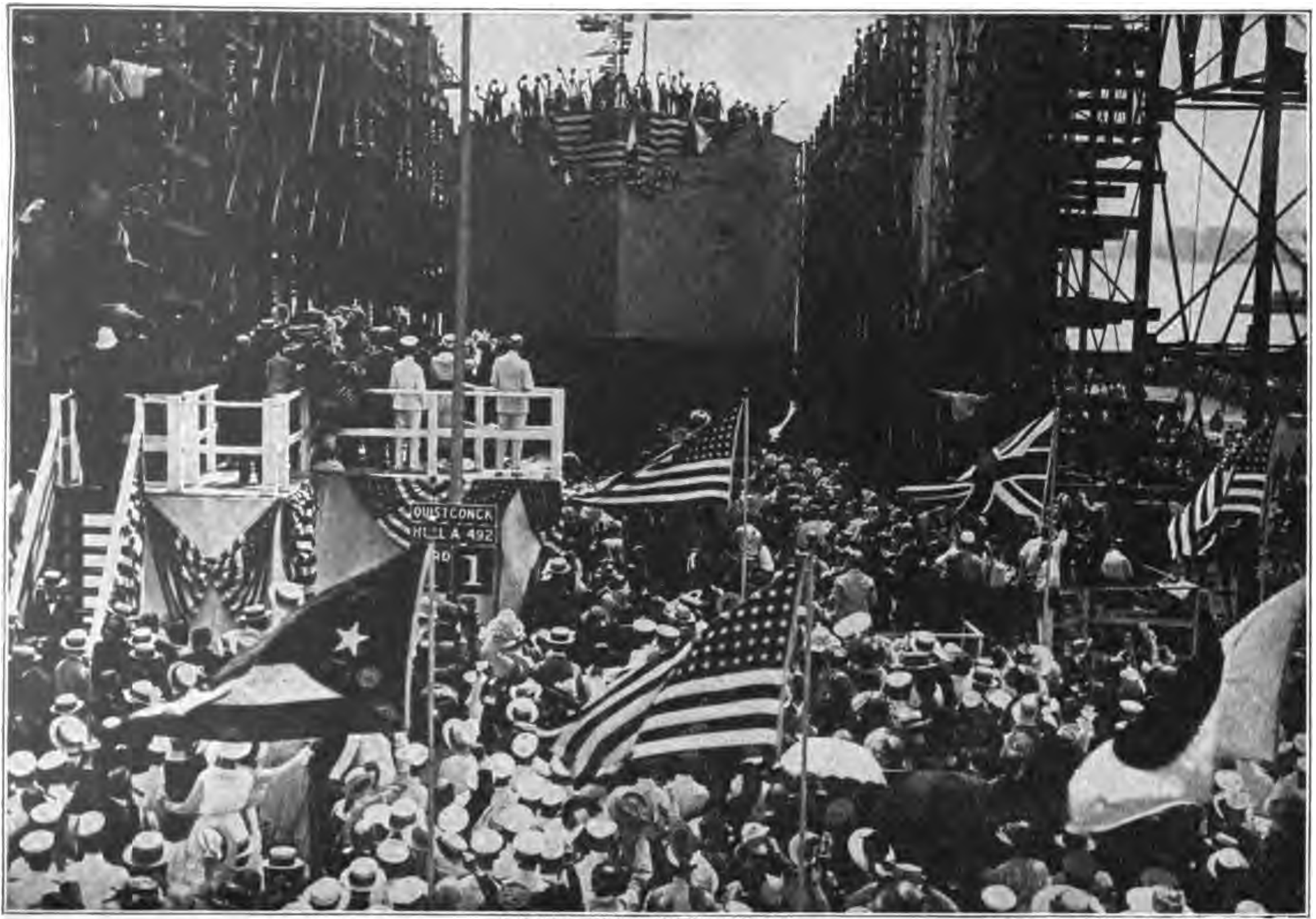
MAKING THE GREATEST SHIP BUILDING PLANT IN THE WORLD.

One of the marvelous accomplishments of the war-time activities of the United States was the erection at Hog Island, near Philadelphia, of the greatest ship building plant in the world, turning out completed ships in less than a year after the work was begun. Hog Island was a swampy expanse of over 700 acres when work was begun in October, 1917. Work was rushed all through the winter. Notice the army of workmen and the veritable forest of poles being driven. An utterly unheard of feat was here accomplished in record time.



A LAUNCHING AT HOG ISLAND. Photo by Paul Thompson.

The first launchings at Hog Island were gala affairs. This represents the presidential party watching the Quistconck glide down the ways. August, 1918, the first ship of a fleet of 180 ships. This ship was constructed in only a few months time. Its keel was laid February 12, it was launched August 5, an accomplishment considered impossible in pre-war days.

with all our shipways used in construction of cargo ships we can make 13,518,000 dead weight tonnage per year, nearly six times the amount formerly deemed the limit. As a result of this great development, we can build ships faster and better than any other country in the world. Our improved methods have revolutionized the process of construction, we accomplished what the world thought impossible. It was an amazing exhibition of resourceful strength.

WHAT THIS VICTORY MEANS FOR OUR COUNTRY.

They are blind who do not see that every advance in civilization has tended to contract the world, to unite all lands, to enable all nations to do a real service to each other by supplying each the other's needs. The world needs our cotton just as we need the sugar, the silks, the spices and the rubber of other lands. The exchange of commodities has increased with every advance in civilization. With the earth freed from the fear of conquest at the hands of autocratic nations, drawn together by ties of friendship and esteem, we may look for a wonderful expansion of international trade. America is now awake on the subject of ships. It is not again going to sleep. We will have facilities on the ocean to deliver our factory and home products and bring to our shores raw materials from other countries, and foreign nations to our doors and carry Americans abroad, as tourists, salesmen, students and creators of international good will. Ships are an absolute necessity for the greater to-morrow now dawning.

WE RESUME OUR RIGHTFUL RANK IN SEA POWER.

This great increase will result in our country's resuming its rightful place in sea power. In the long history of ocean transport, it has been demonstrated that sea power and national prosperity and greatness go hand in hand. The Phœnicians were great, not because they had great possessions or were a great military people, but because they commanded the trade of the ancient world. For the same reason, the City Republics of Italy are counted among the great nations of history. For 400 years Great Britain has been great as a sea power; for the last two centuries she has been mistress of the seas. She owes her existence as a great power, her world-embracing empire, to that fact. The time has now come when the United States can divide the empire of the seas with Great Britain. This is our rightful position—which we with surprising indifference relinquished in the nineteenth century. Our flag should now take its rightful place on the seas. It is rightful because in keeping with our standing among the nations of the world. All Latin America is beckoning us. Across the great Pacific are located the nations possessing the majority of the world's inhabitants. They invite us to come to them with ships wherewith to exchange commodities. This we are now in a position to do, thanks to the industrial triumph we have briefly sketched.

OUR TRIUMPH IN AIRCRAFT PRODUCTION.

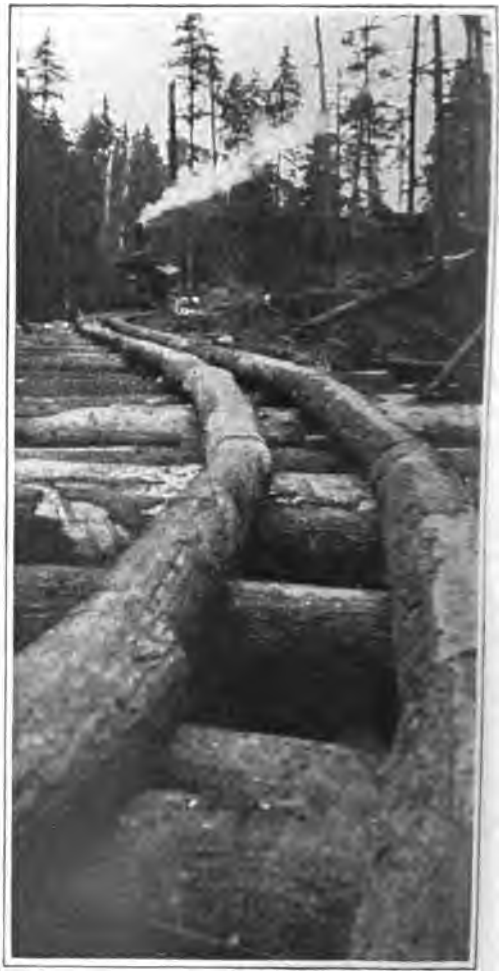
We have outlined elsewhere the wonders of the Flying Age. Our present object is to set forth another striking instance of resourceful strength, which will also contribute to future national good. As in the case of ships, we were face to face with a world problem, as well as one affecting the peace and security of the United States. It was absolutely necessary to produce aircraft with great speed in great quantities. But such construction was new in the world, machinery to produce air machines had to be created. We did have one or two small plants fitted to produce on a small scale the modest machines of peace; none were fitted to produce in quantities the highly scientific machines of war. But again American ingenuity conquered; once more we accomplished what the world believed to be impossible.

SOME OF THE RAW MATERIAL NEEDED FOR AIRCRAFT PRODUCTION.

In order to understand the nature of the problem we must reflect that we needed airplanes by the thousands. The average plane requires 250 feet of first class spruce timber. It is necessary to saw it in a special manner. Only about eight per cent of the total timber produced from the average tree can be used. It requires eleven gallons of specially prepared varnish and fifty-nine gallons of dope for the wings. We did not have a single plant to produce these materials. There is also needed sixty-five pounds of aluminum and over 200 yards of best quality of Irish linen. There was not sufficient linen manufactured or possibly to be manufactured to supply the enormous quantity needed for these purposes. Many thousand gallons of specially prepared lubricant was needed. Castor oil makes the best but we had no facilities to produce it. Let us see how resourcefully America solved this problem.

SOLVING THE TIMBER PROBLEM.

To secure needed timber of the kind most suitable we had to go into the trackless forests of Washington and Oregon where, over rugged ranges of hills, interspersed with canon like gorges, the noblest specimen of spruce trees in the world flourish. The difficulties to be overcome were enormous, but America won. In less than a year, railroads aggregating 175 miles of main lines and 181 miles of spur lines were constructed, over hills, through gorges, into an unbroken forest where the majority of trees were ten feet in diameter and of a corresponding height, with dense undergrowth. In spite of these difficulties, in a few months we were producing 5,000,000 feet of the finest spruce



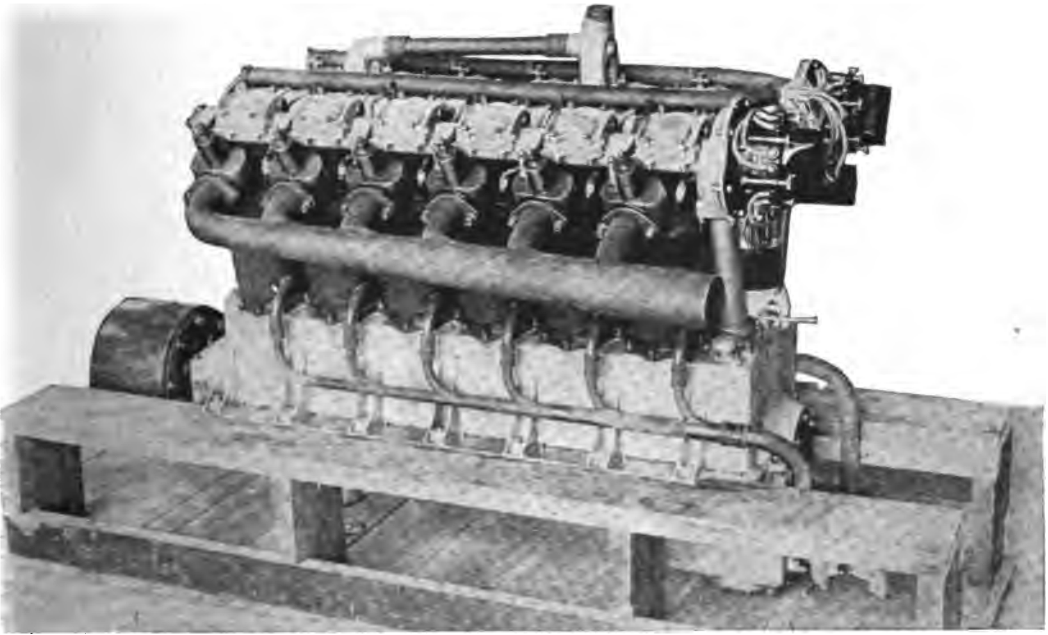
A LOG RAILWAY.

The rails are logs from three to five feet in diameter. This road built in a Washington forest served to supply timber for airplane purposes.

lumber monthly. Before the end of the war we produced 174,000,000 feet, enough to build a commodious board walk, ten feet wide, from New York to San Francisco. In just forty-five days we built the largest cut-up mill in the world, located at Vancouver, Washington. Remember, all this lumber had to be sawed in a particular way.

HOW OTHER NECESSITIES WERE PRODUCED.

In the meantime experts evolved a new way of treating cotton fabric, so that it became as serviceable as the best of linen, in fact, on some accounts better than linen. It had not been thought possible to use cotton for airplane purposes. But necessity, plus American resourcefulness, found a way. than a year we had $20,000,000 worth of factories turning out the best dope ever in-
Dope is not an impressive name but it represents a substance as necessary in airplane construction as the engine itself. Our chemists got to work on this problem. In less vented. Other experts were working on lubricants. The usual result. We invented new processes of treating the products of petroleum, and were turning out thousands of gallons of superior lubricants. But for some reason castor oil is preferable for air engines. We had no way of producing it. A way, then, had to be found. Castor beans were imported from India. The soil and sunshine of California and the American farmers did the rest. Castor oil of the best quality and in great abundance was provided.



Squier.

THE LIBERTY MOTOR.

This motor was a product of war time activities. A large number of engineers united their efforts in designing it. It is regarded by experts as one of the best motors ever produced for aircraft purposes. Quantity production was just achieved as the war ended.

THE LIBERTY MOTOR.

An airplane engine is the most efficient engine ever invented. The parts are as nicely adjusted as the works in a fine watch. We had no engines in America that answered our needs. It had not been invented. So scores of the best engineering experts in this country got to work and in a few weeks evolved the Liberty Motor that is for general purposes admitted to be the best air engine in existence. It is regarded as America's most noticeable contribution to aeronautics. In a few months' time these motors were being produced in quantities. Four of the greatest automobile factories in this country were working day and night on their production. Before the close of the war 13,396 Liberty motors had been produced.

THE LARGEST OFFICE BUILDING IN THE WORLD.

Constructed in Washington in the short space of six months. It illustrates the wonderful industrial strength of our country.

THE DESIRED RESULTS.

In April, 1917, there were only about 300 airplanes in this country. Eighteen months later these preparatory triumphs had been effected and over 11,000 airplanes had been constructed. No other country in three years' time had been able to produce planes in such quantities. A record of the achievements of our booming planes has been given. It is not out of place to remark that it was a realization by Germany that our country could produce airplanes in quantity sufficient to sweep all opposing fleets from the skies that hastened their total collapse.

STUPENDOUS BUILDING OPERATIONS.

In former years our great building corporations considered they were doing an enormous business if they constructed from fifteen to twenty million dollars worth of buildings in one year. They did not dream of the vast development in construction work that counld be accomplished by American resources when need required. In one year we constructed hundreds of millions of dollars worth of buildings all imperatively needed by the government if we were to properly continue our war activities. This was separate from the great cantonment work already described. We would have smiled at the suggestion that such great results were possible in such a limited time in former years. In one year there was built at Brooklyn what is said to be the largest concrete warehouse in the world. Ordinarily years would have been required to construct such building. The total storehouses built for one department of government, if placed end to end, would form a building two and a half miles long, sixty feet wide by fifty feet in height. All built in a year! At Washington in six months was built the largest office building in the world. The total floor space in the building is over forty-one acres. The several wings. if joined, would have a length of one and three-fourths miles, a width of 60 feet. height three stories. A complete circuit of all the external walls, would require a journey of four miles. Eighty-nine miles of electric wires are installed, 50 carloads of radiators were needed for the heating plant. connected by twenty-seven miles of piping. An office force of 10,000 can be accommodated. The buildings to the right, in the background, were used for various organizations formed to meet war needs,—such as the Council of National Defense, the Food and Fuel Administration, etc.

CUMULATIVE EFFECTS.

We have now considered four striking demonstrations of the resourceful strength of our country, put forth to meet world emergencies. Anyone, taken singly, shows an unsuspected reserve of strength. When we reflect that these great achievements were in process of accomplishment simultaneously and in fact, accompanied by the greatest out-pouring of military energy the world ever saw, we are startled by the evidence of industrial power, ability to do, to accomplish whatever seems necessary. We, ourselves, did not know our strength. Having learned it, we will never be content with forty per cent efficiency as in former years. We will aspire to greater things. The world will need as never before the products of our factories, ships and more ships will be demanded on the seas, air transport service is certain to develop beyond anything the world now contemplates. The United States has a great part to play in the tremendous activities of the new epoch on which the world is entering. We have amply demonstrated our ability to meet whatever demands the future has in store.

INCREASE OF AGRICULTURAL STRENGTH.

It is no exaggeration to assert that the United States stood between the world and starvation at the most critical time in history. We were suddenly confronted with an urgent need for food supplies far beyond what we usually furnished. One of the brightest chapters in our history is that relating to the manner in which our agricultural interests responded to this world appeal. It demonstrated that in agriculture as in industry we possessed resources not then understood by the world at large or even by ourselves. In this matter also we have begun to function with greatly increased efficiency. Our horizon of attainments has enlarged. Our records of past achievements will no longer suffice.

HOW THE FOOD PROBLEM WAS SOLVED.

In a year's time ground under cultivation increased 35,000,000 acres, an area nearly as large as that of Illinois, one of our great agricultural states. It was not compact area but represents increased efforts over our entire country, from New England to California, from the Lakes to the Gulf. Gardens to the number of 6,000,000 additional were producing bountiful crops. We must try to realize the surprising latent agricultural strength this fact demonstrates. All crops showed a surprising increase over the average production of former years. The same rapid increase is shown in the number of farm animals. The animals supported in our National Forest Reserves increased nearly 12,000,000 in number. Our beef products increased in one year more than four billion pounds over the average of former years. Four billion pounds, two million tons, one hundred car loads, four thousand train loads, and these figures are those of increase only. Surely this is a most surprising exhibition of resourceful strength on the part of our agricultural citizenship.

WE FEED THE WORLD.

It was this tremendous energy that enabled us to feed the world. It was an exhibition of strength as astonishing and far-reaching in its results as the industrial triumphs. This lesson will not be forgotten. In addition to our rapidly increasing population, our enlarging industrial interests—all of which will demand more food products,—the world itself will require redoubled supplies from the United States. We have demonstrated our ability to produce food in quantities vastly increased over former results. It is another evidence that a period of national prosperity is rapidly approaching. What American can consider these lessons, all testifying to the greatness of our heritage, without experiencing a glow of patriotic pride? These are victories of peace, not of war. The world is to share in our blessings.

THE GREAT CHEMICAL VICTORY.

Few are aware of the vast development of chemistry, recently achieved in this country, or of the transcendent importance of the same. It affords another instance of successfully solving a world problem. The nation that had made the greatest application of chemistry to the purposes of industrial life, with a success so pronounced that competition was crushed, and chemical activity in other countries suppressed, suddenly challenged the entire world to combat, and our country as well as others was deprived of its chemical supplies, some of which—potash and dyes—were necessities in agriculture and business life. American chemists solved this problem, displaying the same spirit of indomitable energy that swept us to industrial and agricultural triumphs, and with equally significant results.

CHEMISTRY REBORN IN AMERICA.

Chemistry in America has been reborn. We had for years been content with a small per cent of efficiency. We possessed the material and our chemists had the requisite technical knowledge. The industry had gone to sleep. We needed the spur of world necessities to rouse us to action. American scholars, however, solved the problem and thereby accomplished an almost unsurmountable task. $400,000,000 of a new capital was invested in buildings and machinery. This triumph represents not only a wonderful present-day achievement but one of glittering future possibilities. No science known to man has greater possibilities awaiting unfoldment than chemistry. Marvelous results have already been secured by a partial revelation of secrets hidden in petroleum, natural gas, and coal tar; of coal smoke, and the refuse from furnaces and smoke stacks. Other fields of chemical research are opening, more promising results still seem to await us. The present age is not simply an electrical age, nor yet a flying age, it is also a chemical age. New explosives, new fertilizers, new sources of power, of food; new materials for construction as well as destruction; new preservatives of life, new means of enriching life,—these are some of the results already achieved. We must not doubt that our genius for discovery and invention, which has been so signally shown in the past, will find in analytic and synthetic chemistry a field of opportunity that will advance us in all ways.

OUR CHEMISTS CREATE A GREAT INDUSTRY.

Potash was specifically mentioned as one of nature's chemicals of which we were suddenly deprived, the most of the world's supply being derived from Alsace. Potash is absolutely essential to the fertility of our soil. The lack of potash threatened many of our industries. American chemists solved the problems. The seas off our shores, lakes on western plains, rocks in our mountains, the very smoke of industrial plants—all concealed stores of wealth that our chemists revealed and the way was thus opened for the development of an enormous chemical industry, henceforth to be one of the great industries of our land.

POTASH FROM SEAWEED.

Potash is held in solution in sea water. How shall we secure possession of it. Mother Nature has for ages been giving us the plainest sort of hint that she was ready to co-operate with us. Seaweeds are nature's way-station in potash production for the needs of men. They are so fashioned by nature that they secrete potash and store it away in their long branches, on the same principle that maple trees secrete sugar. For centuries nature has been ready to hand that potash over to us. American chemistry discovered a way. A $5,000,000 plant has been built near San Diego to treat the kelp—a giant form of seaweed growing off the shores of California. The despised seaweeds, formerly a nuisance, are now so valuable that the state of California has thrown the mantle of the state protection over them and enacted stringent regulations covering their cutting. Here is a source of wealth before unnoticed.

OTHER POTASH SUPPLIES.

We are turning to other sources of supply. There are potash bearing rocks in Georgia; potash can be extracted from the green sands of the Atlantic coast, in the leucite deposits of Wyoming, in the beds of ancient glacial lakes in the West. We have heretofore neglected these sources of supply. Chemistry has disclosed their value, learned to extract vast stores of potash from the by-products of blast furnaces, and from cement kilns. We have wasted great treasures from these sources in former years. The chief engineer of the Research Corporation of New York City asserts that if one-fifth of the furnace capacity of the United States were prepared to treat by electrical precipitation the fumes now wasted, we could secure 300,000 tons of potash—an amount ample for our needs. The time is surely coming when the agricultural needs of our country, to support our 200,000,000 population of 1950, will require all that store of wealth which we but recently threw away.

THE DYE INDUSTRY.

Vast amount of capital is going into the newly created dye industry of the United States. It is a part of the enormous chemical development we have been considering. It is a further proof of the unexpected strength of our country in scientific industry. In former years Germany built up an enormous foreign trade in chemically prepared dyes. The cochineal, madder, and indigo dye industries of Mother Nature were outdone by their chemists who extracted dyes, and marvelous wealth from unpleasant coal tars—such a nuisance to all gas works. It was thought impossible for any country to learn their secrets and duplicate their products. They little understood the spirit that animated American industry, nor the strength wherewith it could be urged. In three years' time the number of plants engaged in producing dye materials increased one thousand per cent. We were exporting forty times as much (in value) of dye material as in former years and our product equalled and in some respects surpassed any dye products previously manufactured. This is still another proof of scientific efficiency and industrial strength; a further notice to the world that in the time at hand of storm and stress and great deeds, America, with her unrivalled resources can be counted on to take a leading part.

FINANCIAL STRENGTH OF OUR COUNTRY.

It is of course evident that a nation capable of accomplishing the great industrial triumphs that we have passed in review, must possess vast financial resources. In this matter, also, our country has developed a measure of strength far in excess of what we were known to possess when the world was confronted with conditions that taxed to the utmost its resources. In earlier decades we talked in terms of thousands of dollars, in later years we ventured into millions, a billion now signifies an ordinary transaction.

In addition to raising billions of dollars by taxes the individual citizens loaned the general government in the course of two years $22,000,000,000 besides investing many millions in war savings and thrift stamps. As a further evidence of our financial strength we loaned other nations about $10,000,000,000 in times of need.

Ten billion dollars! You cannot realize what those figures imply. Were you to commence counting, counting one each second of the day—day and night without ceasing, it would require more than three centuries to complete the count. Or if twenty dollar gold pieces to that value were piled on top of each other, flat sides down, it would make a golden column reaching in length from New York City to Cincinnati, Ohio.

FIGURES NEVER BEFORE APPROACHED IN HISTORY.

The total wealth of the United States is estimated at $250,000,000,000 but it is growing with great rapidity. As it is, it exceeds by $70,000,000,000 the combined wealth of Great Britain, France and Italy. Our National debt is in the neighborhood of $20,000,000,000. But that sum represents a financial burden on our country less in proportion than the $3,000,000,000 debt at the close of the Civil War. It is only about eight per cent of our wealth. The per cent of total debt, compared with the total wealth, of Great Britain, France, and Italy, is thirty-six. Further, our debt—vast as it is—is only about one-third of our national income for one year.

NATURAL WONDERS OF THE UNITED STATES

The ancient world possessed Seven Wonders, all the work of men. Of the seven, only one remains—The Pyramids of Egypt. Only one of the others would strike us as very wonderful. If the accounts of the Hanging Gardens at Babylon can be relied on, they must have been stupendous and wonderful works. The Statue of Jupiter at Athens was, of course, a masterpiece of art.

In the United States, nature has, with infinite patience, working through enormous periods of time, excavated canons and valleys, utterly surpassing pyramids or temples. She has embellished them with carvings that no artist ever equaled, and in fossil remains and rocky scrolls, she has left a record of age-long activities, more interesting than any penned by historians. These constitute natural wonders, in comparison with which the greatest wonders of antiquity are as childish toys.

THE YELLOWSTONE PARK.

The Yellowstone Park is the largest of our national parks. Originally, it contained 3,344 square miles, but this area has been virtually doubled by forest reserves on the east and south. It is a big wholesome wilderness, about one-tenth as large as all of New England, situated on the broad summits of the Rocky Mountains, from six to thirteen thousand feet above the sea. It is set aside as a grand health, pleasure and study resort for the nation, for all the world. The central portion, densely forested, is a comparatively level volcanic plateau, amid sublime scenery.

This central area is dotted with lakelets, one of which is thirty square miles in area. No other lake in North America of equal area lies so high, about 8,000 feet, or gives birth to such a noble river—the Yellowstone —whose waters finally reach the Gulf. Glacier meadows and beaver meadows are outspread with charming effect along the banks of its numerous streams, forming park-like expanses in the woods, and in this park are found the most wonderful geysers in the world, more than 100 in all.

THE GEYSERS.

The geyser basins are mostly valleys on the central plateau that were eroded by glaciers, after the greater volcanic fires had ceased to burn. All have read about geysers. They are nature's artesian wells in which, however, the spouting column of water is boiling hot, and very irregular in flow. For minutes, hours, or days all is quiet in the pool; then a column of water leaps forth, varying in diameter, rising to varying heights. It is forced up by the pressure of imprisoned steam, probably deep in the interior, and a great deal of steam is mingled with the water. The pressure relieved, the waters cease to flow, but resumes activity generally at an uncertain time, in the near future. In some cases the interval between the outbursts is known and varies but a few minutes. Geysers are found in other volcanic regions of the earth, such as Iceland, New Zealand and Japan, but geysers of the Yellowstone surpass them all. Their columns of water are from fifty to sixty feet in diameter, rising from a few feet to three hundred feet in height. They are sustained at their height with tremendous energy, from a few minutes to almost an hour, standing erect, hissing, throbbing, booming, as if storms were raging beneath their roots. Their sides are roughened or fluted, their tops masses of feathery branches. At times the spray is blown aside and the beautiful columns are seen against the background of pine-covered hills.

The columns display various forms; some are flat or fan-shaped, some broad and round-headed like oaks; others are low and branching near the ground like bushes; a few are hollow in the center like lily stalks. Some of the craters, from out which the columns rush, are massive and picturesque, adorned with outbulging flower-like formations, from which, as a center, the stony pavements shope in thin, overlapping layers, interrupted here and there by low terraces. At the north end of the park, where the waters issue from the side of a steep hill, the deposits form a succession of white travertine terraces, tinged with purple, draped in front with clustering stalactites, each terrace having a pool of indescribably beautiful water in a basin with a raised rim, the whole, when viewed at a distance, looking like a broad, massive cascade pouring over shelving rocks in snowy, purpled foam.

The Excelsior Geyser, near Prismatic Spring, is the greatest of all known geysers. It is said to throw a column of boiling water 60 to 70 feet in diameter to a height of from 50 to 300 feet at irregular intervals. The Firehole River, which sweeps past, is at ordinary stages a stream about three hundred feet wide and three feet deep; but when the geyser is in eruption, so great is the quantity of water discharged that the volume of the river is doubled, and it is too hot and too rapid to be forded.

HOT SPRINGS.

Geysers are not the only wonder of this wonderful park. There are over 4,000 hot springs, with water at all degrees of temperature, some boiling hot. Nature seems to have set up one of her laboratories in the park. Generally she prefers to do her work under cover, far beneath the surface, but it is all in the open in the Yellowstone. She has innumerable pots and kettles—rocky bowls and crater-like depressions—where she seems to be cooking, boiling, steaming and stewing all sorts of rocks and earths. Some pots are sulphurous mush, stringy and lumpy; others are pots of broth as black as ink, tossed and stirred by gigantic but invisible ladles; others are full of colored paste, yellow, brown, red, all colors. They are known as paint pots; others are filled with scalding mud which is tossed up, sometimes to the height of thirty feet, as if it were a gigantic pudding, the surface of which is blown up in blisters with escaping steam.

All this indicates the near presence of great internal heat. In Tertiary times, this section was a scene of great volcanic activity, probably far exceeding anything we know at present. Not once, but many times did the volcanoes here situated belch forth floods of lava, boiling mud and ashes. The whole country was covered to the depth of at least a mile. Then, after a vast interval came on the long winter of the Glacial Age. The conditions now existing in Greenland held sway then in the Yellowstone. The mighty ice of the glacier plowed and crushed and wore away much of the lava covering, and left the surface features as they are today. The shortest interval of time we can assign to the on-coming, continuance and gradual passing away of these Arctic conditions is expressed—not in centuries—but in thousands of years. Here and there in the distant mountain recesses are found masses of ice, covering a few acres, minute models, on a

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A YELLOWSTONE GEYSER IN ERUPTION.

Courtesy National Park Service, Dept. of the Interior.

ONE OF THE BUFFALO HERDS IN YELLOWSTONE PARK.

The Yellowstone park is by far the largest and most successful wild animal reserve in the world. There are two herds of buffalo in the park, both increasing with great rapidity, but they are insignificant compared with the countless herds of early years on Western plains.

Courtesy National Park Service, Dept. of the Interior.

THE GREAT FALLS OF THE YELLOWSTONE, NEARLY TWICE AS HIGH AS NIAGARA.

The Yellowstone rises in the lake of that name in the great Yellowstone Park. Plunging over these falls it enters the wonderful Grand Canyon of the Yellowstone, where walls gleam in color more gorgeous than that of the Grand Canyon itself.

Courtesy National Park Service, Dept. of the Interior.

CASTLEWELL, ONE OF THE INNUMERABLE HOT SPRINGS.
There are over 4,000 hot springs in the wonderful Yellowstone Park. The waters vary in temperature.

Courtesy National Park Service, Dept. of the Interior.

NATURE'S BEAUTIFUL WATER BASIN.
The basin has a raised rim of white travertine, tinged with purple draped in front with clustering stalactites. The effect at a distance is that of a massive cascade pouring over shelving rock in snowy, purpled foam.

childish scale, of the great ice cap of the Glacial Age, which carved and fashioned the surface feature of this beautiful park.

The existing geysers, hot springs, and mud bowls show that not far within the surface, the volcanic giants are fitfully sleeping. Should they at some future time shake off their lethargy and once more lay this section in ruin, it would only be in modern times the repetition of an experience, time and again repeated in the distant past. We have no assurance that such will not be the case. The sudden outburst of true volcanic activity in recent years of Mt. Lassen in California—the only volcano, though very feeble in action, in the United States—shows that nature is testing some of her old vents and may conclude to utilize them again.

PETRIFIED FOREST OF THE WEST

The Petrified Forests of the Yellowstone Park and Nevada are among the greatest natural curiosities in the world; and nothing more excites the imagination than to gaze at these fallen monarchs of unknown thousands of years ago. Probably the most impressive forest, or rather series of such forests, is in Yellowstone Park. Amethyst Mountain presents a section two thousand feet high of roughly stratified beds of sand, ashes, and conglomerates, coarse and fine, that has been eroded by glacial and post-glacial action. On the ledges of that section can be seen the trunks and stumps of from fifteen to twenty ancient forests, ranging one above the other, standing where they grew, or prostrate and broken, like pillars of ruined temples in desert sand. It is a forest in stories, the roots of each spread above the tops of the one beneath. This is easy to read, but the most of us fail to grasp the wondrous story such a record implies.

Take the lowest forest first, though there is nothing to distinguish it from the others. Near the roots of the ancient trees we find the seeds, leaves and bushes of other trees that flourished in that distant time. They were just such trees as are now growing along the southern flanks of the Alleghanies, testifying to a warm and genial climate. And these great trees grew from five to ten feet in diameter; some of trunks still standing are fifty feet high. Thus many centuries of quiet growth passed. Then the volcanoes broke loose. The entire section was buried in mud and ashes; other centuries elapsed, a new soil formed, and a new forest grew up over the entombed one; and this process was repeated as many as twenty times. Reflect on the slow processes nature employs in her work and try and imagine the vast period of time such a series of stratified forests represents. Then came on the long Glacial Age, when for thousands of years the whole section was exposed to the grinding actions of ice, perhaps a mile thick, uncovering portions of these buried forests so that we can read the exposed records.

ARIZONA PETRIFIED FORESTS.

In the eastern part of Arizona, just outside the Painted Desert, glistening like a huge field of gems, is the most famous petrified forest in America. It is a parched and almost barren expanse, covering thousands of acres, strewn with petrified remains of an ancient forest. This whole section is so interesting—a chapter of a long vanished past—that the government has thrown its protection around it and made it a natural park, not large, but certainly very interesting. It tells us, in the first place, that this now barren section, long ages ago, was a fertile area, covered with noble forests, huge trees, ten feet and more in diameter, that must have been considerably more than one hundred feet high, for some of the fallen logs are that long now.

Then volcanic action, probably from the north, overwhelmed the forest, and drifting layers of sand covered it to a great depth. But the country was sinking. Over it all rolled the waters of an inland sea; the sea vanished; volcanoes belched forth their spume over the old sea bed. This cycle of events extended over an extremely long period of time, many, many thousands of years. Then in the long course of ages, the erosive forces of nature, water and air—removed large parts of surface, leaving isolated mesas here and there. But for centuries this section has been arid, showing another change in progress; but as the old surface was eroded, the fallen monarchs of thousands of years ago were once more brought to the surface, and there they are—all solid stone, of the most beautiful kind, some logs broken in pieces, but others are perfect. We can see the bark, count the rings of the old tree. They now gleam in the sunshine after sleeping in their graves for thousands of years. On the nearly precipitous sides of some mesas, representing uneroded portions of the old surface, here and there the projecting ends of logs protrude; their resurrection is not complete. In one place an old fallen trunk spans a gorge, forming a stone bridge, and in the gorge small trees of to-day are growing, the only place in the park, by the way, where anything is growing. In order to preserve this ancient trunk, the government has built from the ground supporting abutments of stone. Of a truth, no other country has such wonderful remains that so eloquently testify to the lapse of ages, to climatic conditions of a long vanished past, to the tremendous energy of ancient volcanoes, to the rise and fall of continental expanse, to the presence of inland seas and abundance of water, where now is an arid waste.

CANONS OF THE WEST.

The surface features of a country have largely been molded by the actions of running water. The rivers did not choose their course where they are now located because the valley existed, down which they commenced to flow, but the valleys with their winding, graceful contour lines are situated as they are because the rivers in the course of time have excavated them. The river valleys thus cut vary in many ways. Where they have been cut through rocky strata, they often present precipitous sides and are known as canons. Cutting down through rocky strata of varying density and color, the canon walls are often beautifully colored and polished and here and there harder masses of rocks projecting into the gorge have been fashioned into projecting spires, turreted walls, castellated domes. At first sight we can scarcely believe that running water could be the agent of erosion; we are apt to think it could have but little effect on the rocky walls. But running water alone does exert a great erosive power and gorges have been slowly eaten back by its force. The gorge of Niagara below the falls has thus been formed. If, in addition, the stream be swift in its flow and contains a great deal of sand—as the Colorado—it acts like

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ARIZONA PETRIFIED FOREST

Courtesy National Park Service, Dept. of the Interior.

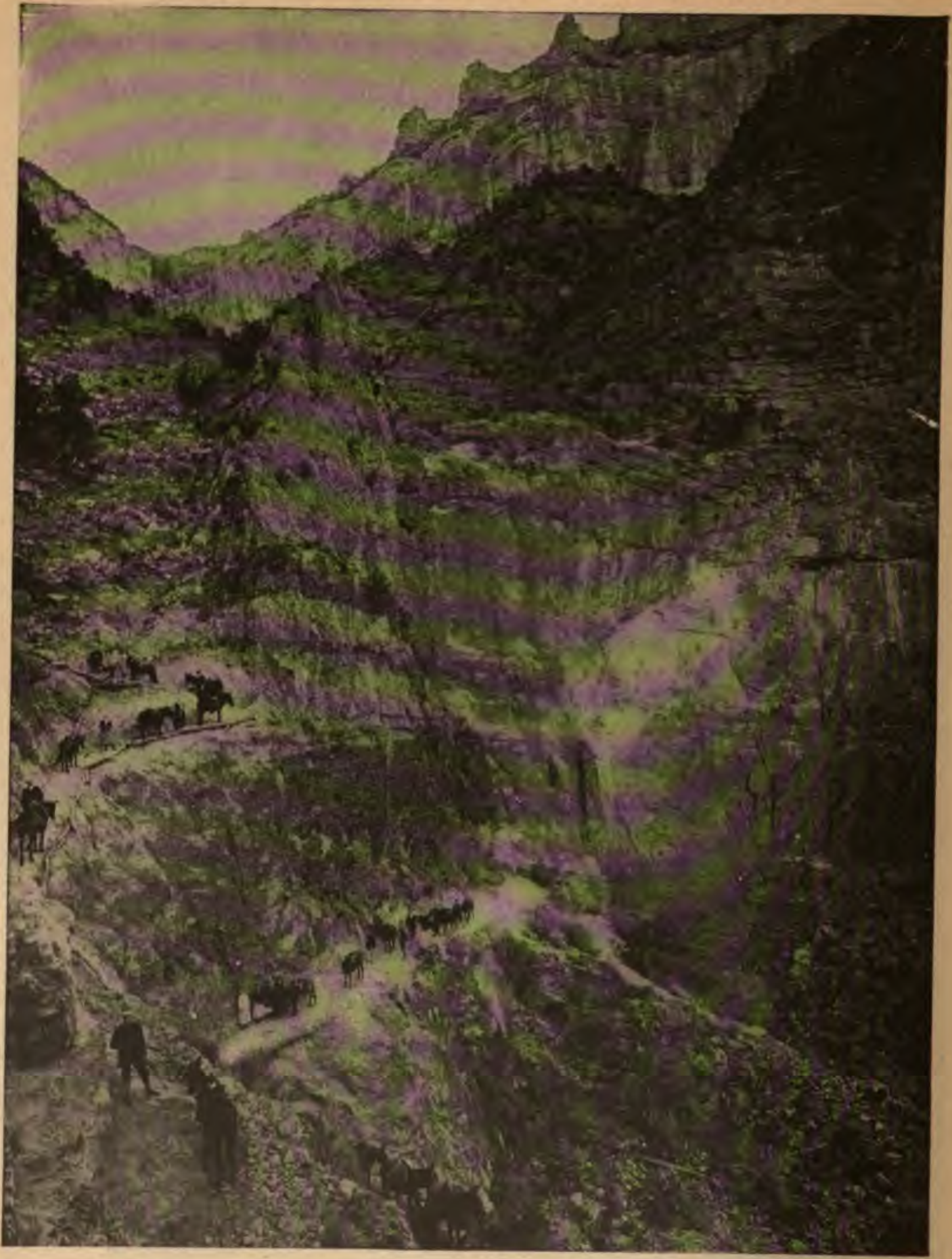
GRAND CANYON OF THE COLORADO.

Carved by nature's magic hand. The clouds and the sunset, the moonrise and the storm invest this scene with a splendor no mountain range can surpass. Peaks shift and glow, walls darken, crags take fire, and gray-green mesas, dimly seen, gleam like opalescent mountain lakes.

Courtesy National Park Service, Dept. of the Interior.

ESCAPEMENTS IN THE GRAND CANON.

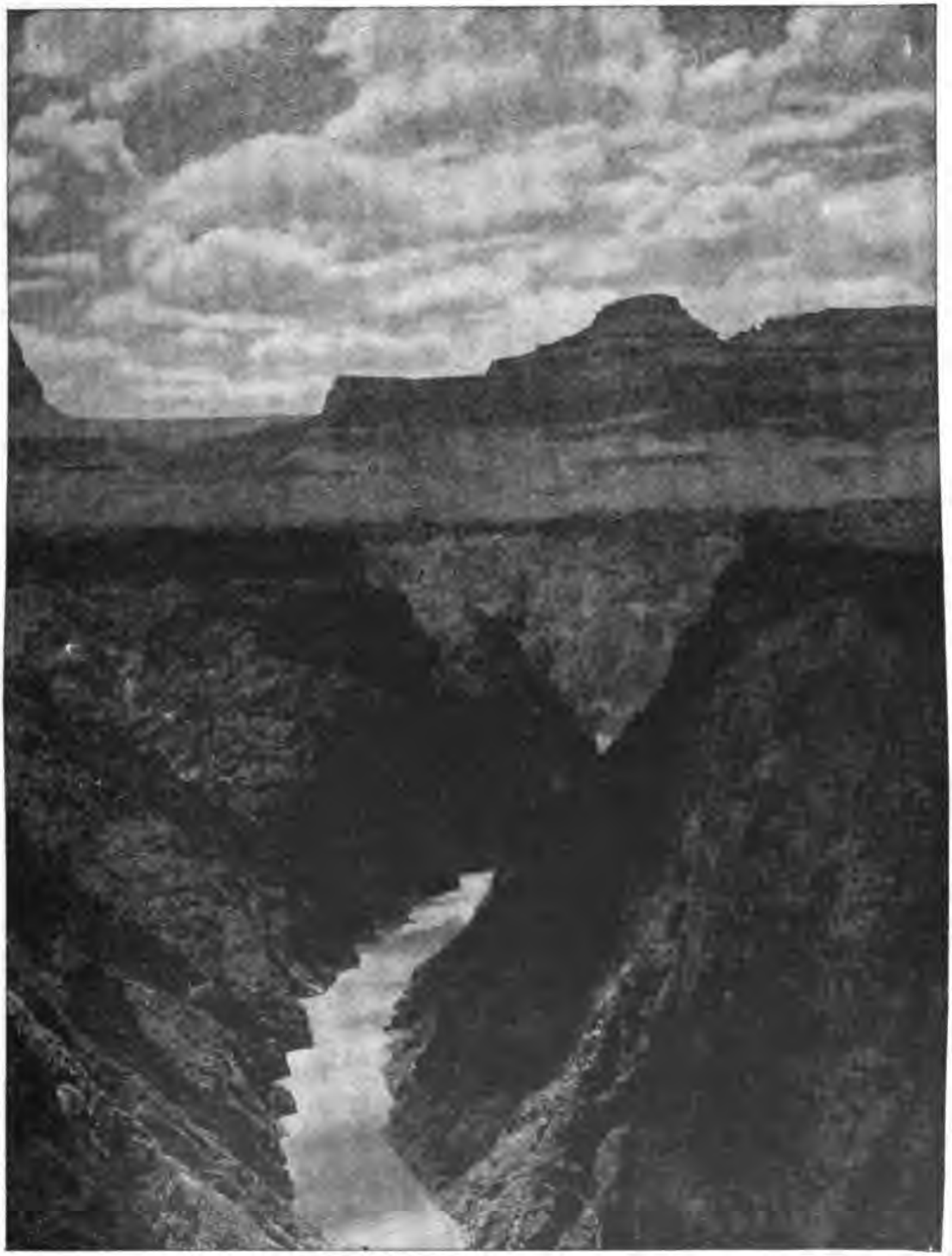
Here Nature has for ages carved and chiseled and wrought; the result is these miles of canon gorges and wall-rimmed expanse where for long years the troubled surface rested in its slowly rising movements.



Courtesy National Park Service, Dept. of the Interior.

JACOB'S LADDER ON BRIGHT ANGEL TRAIL.

Scene in the Grand Canon of the Colorado. This trail begins near El Tovar and descends to the river itself. Though this is in the wildest section of the canon notice the broad and safe trail winding down the canon side.



Courtesy National Park Service, Dept. of the Interior.

WHERE MESA AND CANON JOIN.

The mesas beyond are reminders of a time before the Colorado excavated its mighty gorge. In the flaming glory of sunset the whole canon is transfigured, as if the sunshine of ages gone, stored up in the rocks, was now pouring forth, flooding with its glory earth and sky.

a great chisel and cuts its rocky channel with comparatively great rapidity.

The Yellowstone River that issues from the Yellowstone Lake, flowing north, cuts through the Washburn range of volcanic rock, mostly rhyolite. It has cut out about twenty miles of the most magnificent canon formation. The river at the head of the gorge plunges down in two great falls, respectively one hundred and three hundred feet high. The canon itself is twenty miles long, about 1,000 feet deep. The precipitous walls are carved into fantastic shape, and are brilliantly colored. The walls from top to bottom burn in a perfect glory of color—white, yellow, green, blue and various shades of red, indefinitely blended. The effect is surpassingly beautiful, and fills the beholder with admiration not unmixed with awe. These are Nature's carvings and paintings on a scale of magnificence no efforts of men can equal.

GRAND CANON OF THE COLORADO.

The Canon of the Colorado is the grandest exhibition of the erosive carving power of running water on a gigantic scale in the world. There is nothing that can compare with it. The Colorado River takes its rise in the mountains to the south of the Wyoming Park, flows generally south and west to the Gulf of California. On its way it gathers in many tributaries. It cuts across the elevated border of the inland sea which deposited great beds of limestone and other stratified rock. During late geological ages, this whole section has been gradually rising —but the periods of emergence have alternated with prolonged periods, when the crust was stationary. At such times rivers do not sink their channels; they meander from side to side, broadening their valley. Therefore the Colorado River has, in the long course of ages, cut numerous wide terraces for a curving distance of two hundred miles. That course of the river through the northwest corner of Arizona, shaped like a gigantic, irregular letter S, for a distance of more than two hundred miles is a canon like gorge which has been excavated on an average about half a mile in depth. The central portion of this course, where the general direction of the river is from the southeast to the northwest—a distance of about sixty miles—is known as the Grand Canon of the Colorado, though the whole distance is a magnificent example of river erosion.

The spectator, standing on the brink of the canon on one side, will see the opposite brink, but will not realize that it is miles away—from eight to thirteen. What he sees before him is a bewildering complexity of short terraces ending in precipitous sides to a lower level. He is gazing upon a labyrinth of architectural forms, fretted with ornamental devices, festooned with lace-like webs formed of broken rocks from the upper cliff, painted with every color known to the palette in pure, transparent tones of marvelous delicacy. It is not one single canon, rather a maze of canons. Each little side rivulet seemingly has vied with the large river and contributes its side canon to the general effect.

The main river canon is in places more than a mile deep and the rocky walls rise almost perpendicular in places. They are carved and buttressed with all sorts of fantastic rock forms. Mere figures can not convey a sense of the bewildering beauty and complexity of the canon, though they may confer a slight impression of the work the river has performed. The river that we

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THE YOSEMITE FALLS

The falls in the background have a perpendicular descent of 1,600 feet; the narrow, rock-ribbed channel connecting the two falls, descends by a series of cascades 500 feet, the lower falls are 500 feet in height.

finally reach at the bottom of the main canon is a swift-flowing stream, racing along at a speed of forty miles per hour. What a profound antiquity is here indicated from the time the inland sea vanished and the river commenced to drain the plateau region, and to excavate its valley through the sedimentary strata. Each broad terrace means a period when the uplifting forces of the interior were quiet, each precipitous descent to a lower level is a period of elevation; at such times the river rapidly sinks its channel, and this latter action is still going on—that is, the canon is still being excavated. In other words, nature has not yet completed her canon building operations. A thousand years from now this great work may present features very different from its present outline, but it will ever remain one of the great wonders of our country.

THE YOSEMITE VALLEY

The Yosemite Valley is the central attraction of the Yosemite National Park—thirty-six miles in length by about forty-eight in breadth, thus over 1,700 square miles in area. It is due east of San Francisco, about 150 miles. Both the Tuolome and Merced Rivers have their source in this park, which contains innumerable lakes and waterfalls, with park-like stretches of meadows; the whole section is heavily forested, not a tangled underbrush but the noblest trees in the world. There are lofty granite divides, ice-sculptured canons, crystalline pavements, and snowy peaks, twelve and thirteen thousand feet high, arranged in open ranks or clustering groups of peaks. They are a part of the Coast Sierras. This section shows the action of glacial ice on a grand scale, which polished, eroded and ground down the old surface and dug out great gorges here and there. There are immense forest reserves both to the north and the south of the park proper. Besides the Yosemite Valley, there is the beautiful Hetch-hechy Valley a few miles to north, a wonderful thing in itself.

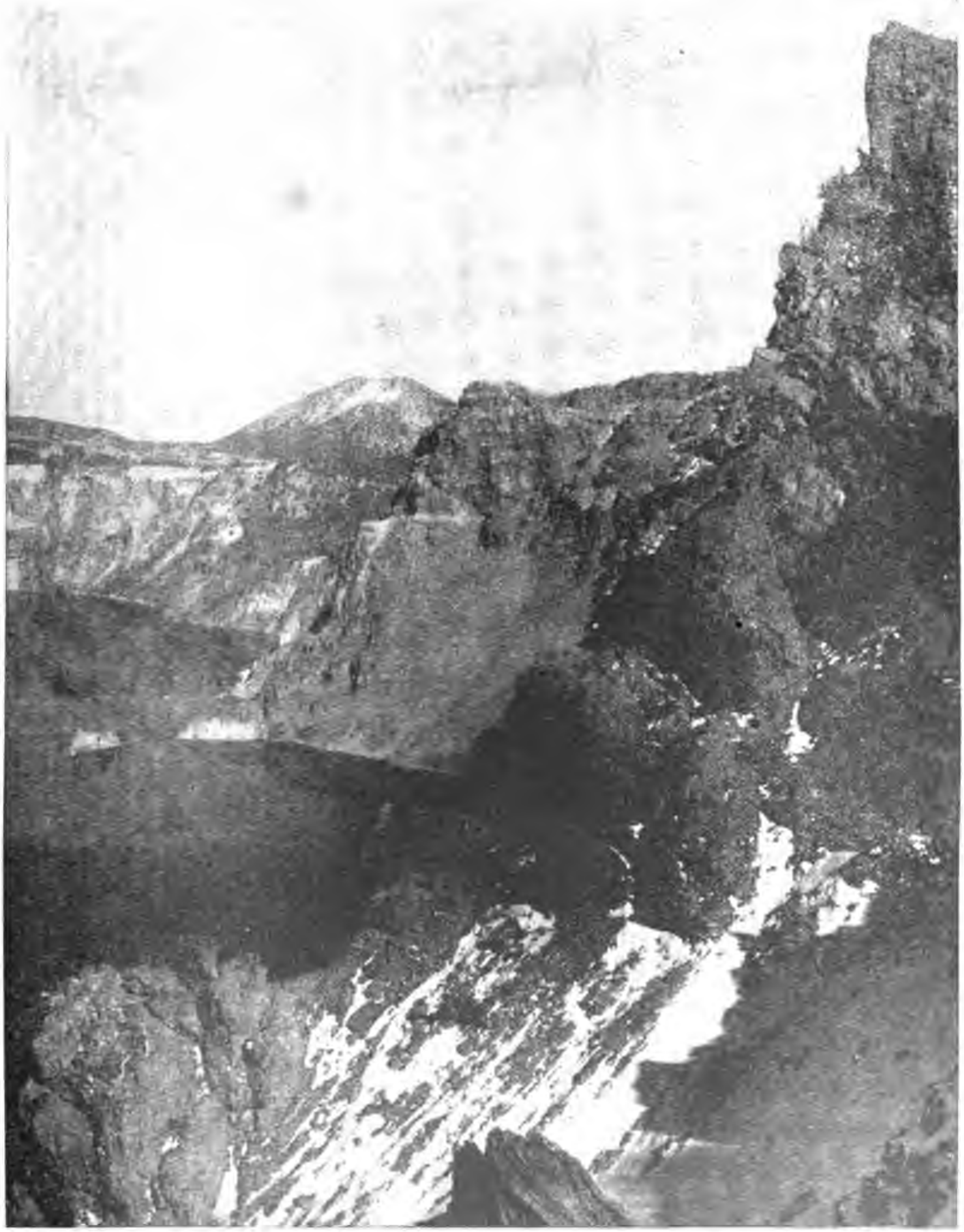
The Yosemite Valley in the heart of the park is another of nature's wonderful works. It is a sort of great pocket, cut deep in the recessed hills. It lies east and west, about six miles long, from a mile and a half to two miles wide. Through it the Merced River winds, entering the valley through a narrow rocky canon known as the Tenaya Canon, and escaping by a rock-strewn channel at the west end. The center of the valley is a level area containing in all about 1,150 acres; of these, about 750 are meadows. Upon the meadows are grouped in groves more or less dense, cedars and oaks, the latter often bearing large growths of mistletoe. In general, the meadows are covered with grass and innumerable flowers. These meadows are widely overflowed with water in the spring, caused by melting snows among the mountains beyond. The banks of the winding rivers are fringed with willows, poplar, evergreen, etc. As we approach the side walls of the valley we come upon rocky ledges rising to the walls proper and broken masses of tumbled rocks, in knolls of all shapes.

Trees are growing wherever there is enough earth to afford room for the roots. The side walls rise to a height averaging fully 3,000 feet. They are not perpendicular in all places, and trails lead out, but such

Courtesy National Park Service, Dept. of the Interior.

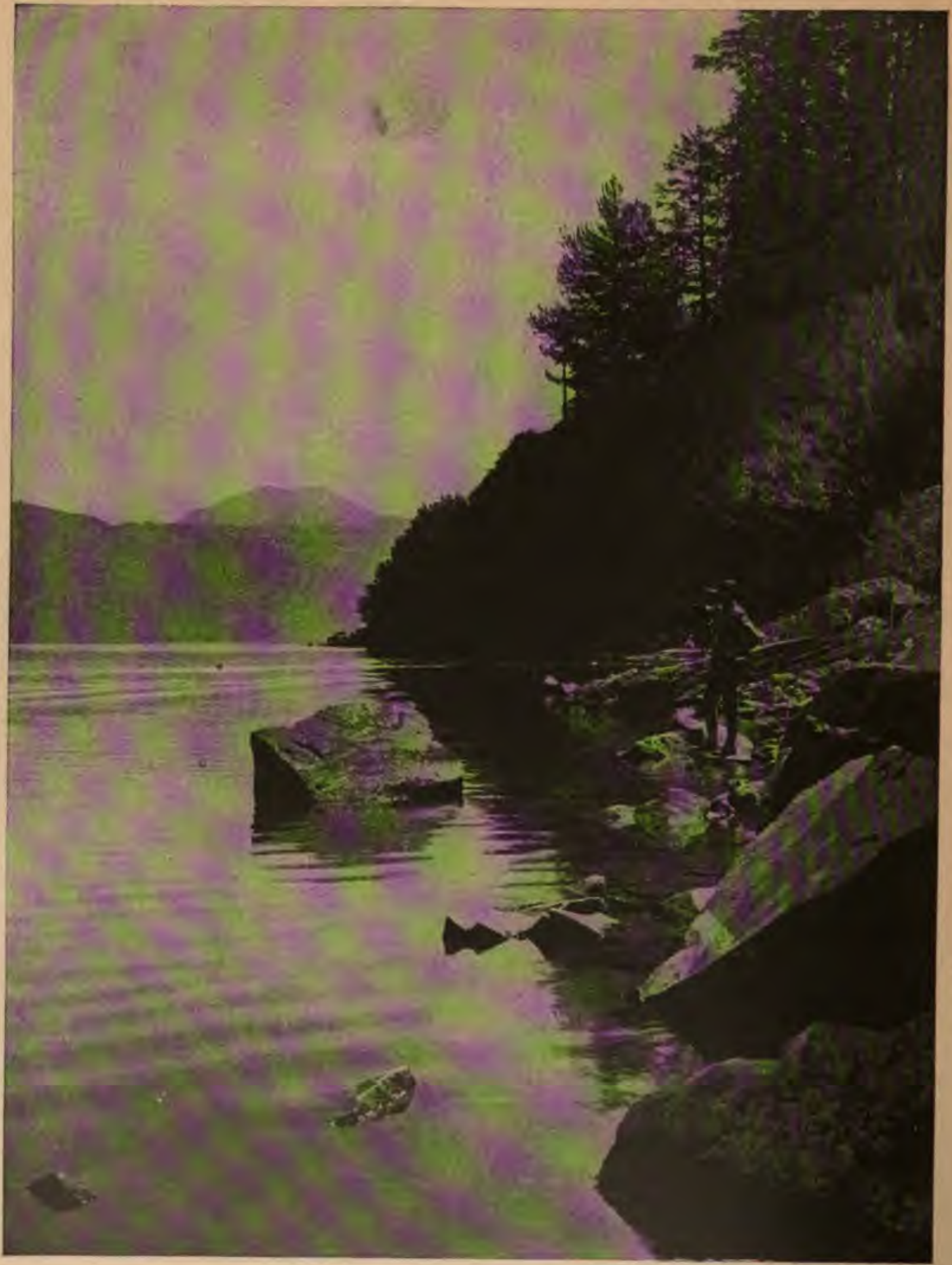
ODESSA LAKE, ROCKY MOUNTAIN PARK.

One of the beautiful lakes of our western parks. It is almost encircled by snow-spattered summits. In the distance, note the rivers of ice (glaciers) descending to the valley there to feed this mountain lake.



CLIFFS OF A THOUSAND PEARLY HUES

Here Nature paints in brilliant hues; grays, silvers, and pearls in the carved and fretted lava walls; snow patches of gleaming white; olives and pine greens of woods and moss; vivid cloud specked azure of the skies; and the lakes changing shades of blue.



Courtesy National Park Service, Dept. of the Interior.

AROUND THE SHORES OF CRATER LAKE.

Crater Lake presents such a bewildering combination of scenic charms that it has been created a National Park. The shores of the lake are the lava sides of an old crater. The cliffs are beautifully tinted, most fantastically carved.

Courtesy National Park Service, Dept. of the Interior.

LOOKING FROM FLATTOP ACROSS TYNDALL GLACIER GORGE.

Notice the glacier in the center, a shrivelled remnant of the mighty glacier of ages ago. From the heights stretches on every hand a tumbled sea of peaks, dark gorges open underfoot; massive walls of granite from across the ice filled valley.

trails are few and always steep. In most parts, the walls are nearly straight up and down. Like all canon walls, they are buttressed with strange carvings and projections here and there, and great pinnacles and domed surfaces and spires rise, perhaps from the bottom of the walls themselves, perhaps only from the top, standing up several thousand feet higher than the walls proper. They are portions of the old landscape that were too firmly rooted, or composed of rocks that withstood the crushing, onward march of the great glacier. These pinnacles and crags lend sublimity to the scene.

Though the river itself enters the valley by the Tenaya Canon, there are several streams that do not, but leap boldly down from the surface level in one or more great falls. We must not forget that the Sierras are but a few miles away, many are snowclad, and rivers issue from their lower levels, and some of these streams find their way to the Yosemite Valley. They are remnants of the numerous mighty streams which poured their torrents over the brink of the canon walls ages ago when the glacial winter was passing away.

In the spring of the year, when the snow begins to melt, dozens of torrents pour into the valley, leaping from the cliffs, carrying with them great rocks and immense quantities of coarse sand and gravel to the lower levels. The air then is filled with the roarings of waterfalls. But there are several streams which pour their waters into the valley at all seasons, over falls of great height and beauty. The Yosemite Falls is probably the highest falls in the world. It is seventeen times as high as Niagara—making a descent of 2,634 feet. In the summer time when the river is low the wind is able to blow the falling water some distance away, but in the spring the falls are indescribably grand. The Bridal Veil Falls is divided into two sections of 600 and 400 feet, respectively.

Travelers who have journeyed the wide world over, been under the spell of the Swiss Alps, passed up and down the storied Rhine, enjoyed the placid beauty of Killarney, gazed in awe at the towering Andes, have not found words to describe this gem valley on the western flanks of the Sierras of California, with its surpassing waterfalls, its park-like meadows, its vast confining walls, carved and polished and sculptured by nature, with its jagged sky line of domes, minarets and peaks which sentinel-like guard its approaches. It rightfully takes its place as one of the great natural wonders of our country, more wonderful far than any ever built by human hands.

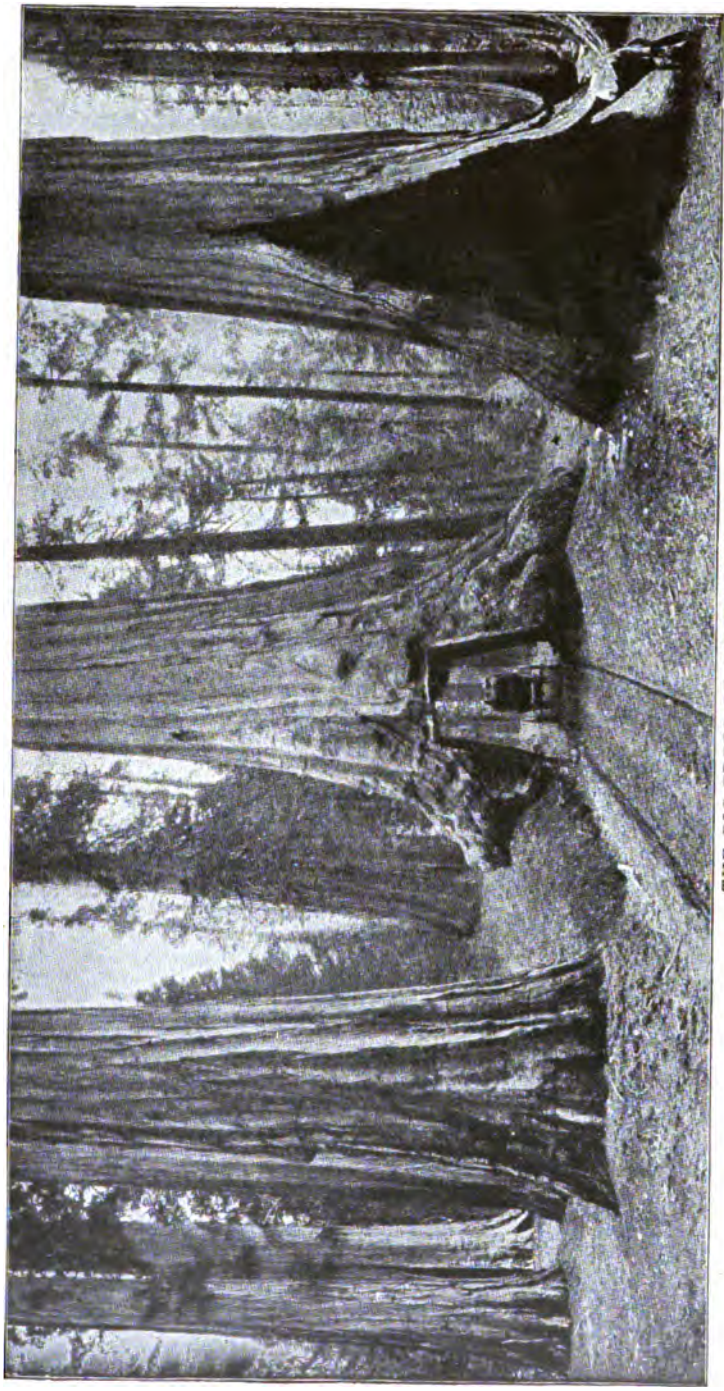
THE GREAT TREES OF CALIFORNIA

In a former geological age nature delighted in creating gigantic forms of animal life. Huge animals exceeding many times the average bulk of the animals of to-day swam in the waters of old oceans, stalked through the forests and waded the marshes of ancient continents, and gigantic bird-like reptiles flew in the air. But such bulky forms were not suitable for her purposes and have been replaced by the smaller animals of to-day, leaving only one species—the elephants—to remind us of former efforts. But animals were not the only giants of early days. Nature also evolved huge forms of plant growth. Many ferns, to-day graceful plants a few feet or inches in height, were represented by trees thirty and forty feet high in the forests of early ages. The giant plant forms of all were trees growing in profusion in the forests of the Miocene Age.

That whole period, judging from the remains of animals and plants and geological evidences of climate, was one of the most beautiful ages the world ever saw. Many species of trees, many times larger than the average trees of to-day, flourished in the forests of the Miocene Age, not only in our present temperate sections of the earth, but .far to the poles in both America and Europe, then connected by a land mass. And in this case, also, nature has left growing in the forests of California representatives of these old tree-giants; they are the famous Big Trees of California.

THE SEQUOIA.

The Sequoia, of which there are two varieties—the Sequoia proper and the Redwoods—grow on the slopes of the Sierras from the northern boundary of the state of California to the great timber reserves south of the Yosemite Valley, but only in detached localities. There



THE BIG TREES OF CALIFORNIA.

are two important groves of Sequoia, the Calaveras and Mariposa groves. They are the property of the state of California and are made state parks. But there are other great groves of these trees in the immense national forest reserves on the north and south of the Yosemite Park. In this section trees of all ages are growing. The government will of course protect them. They are such a great natural wonder that government, state and national, should guard them in every way.

THEIR SIZE.

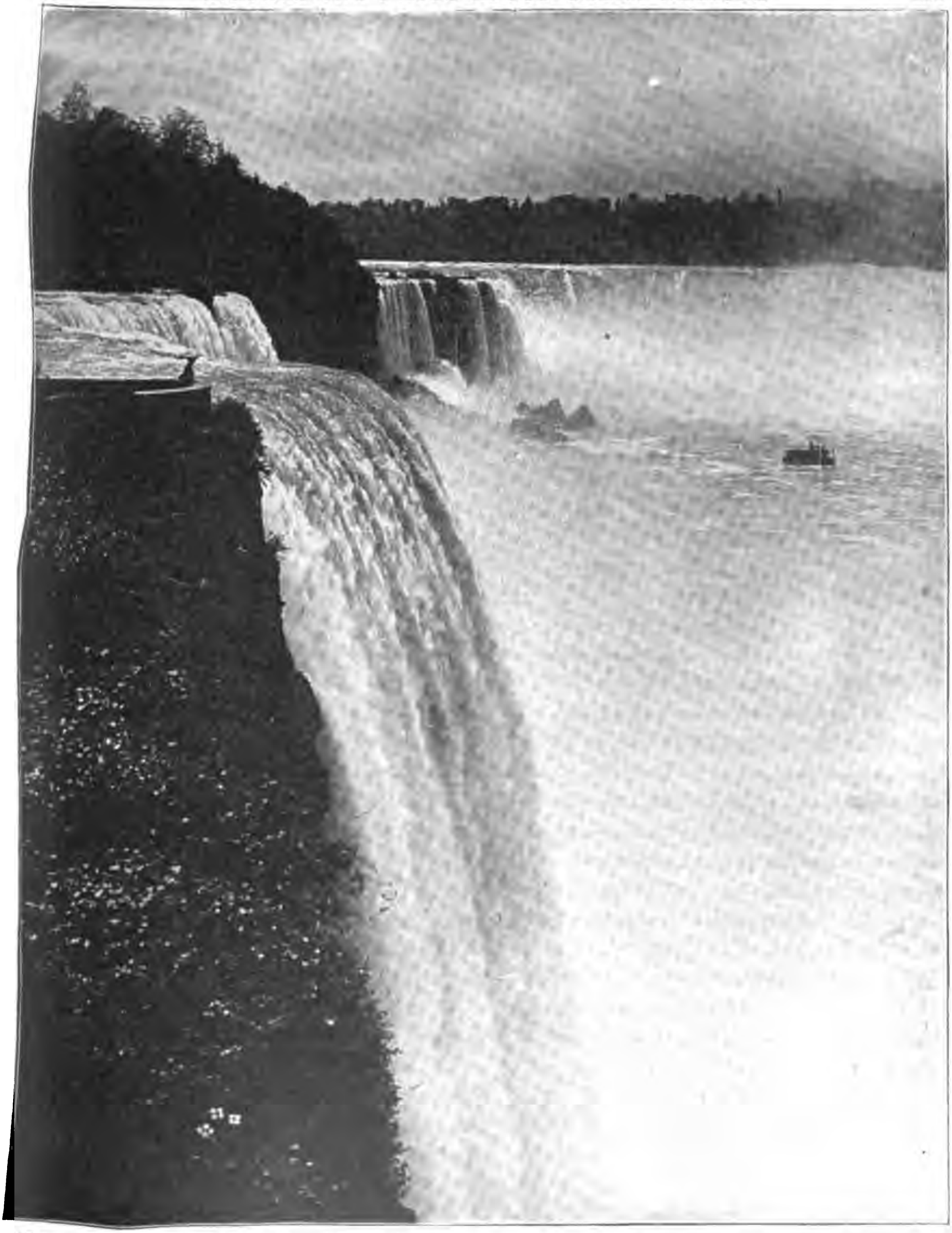
The average full-grown tree is 30 feet in diameter. Let the reader try and reflect what that means. Call to mind the biggest trees with which you are acquainted. How many of them exceed four feet in diameter? One of five feet is truly a wonder. The average big tree in the forest is not more than three feet. But the average Sequoia is 30 feet in diameter. Step it off on the sidewalk and try and imagine such a tree. The circumference or girth is over 90 feet. Measure the circumference of an average tree and then try and imagine what a tree over 90 feet in circumference would be like. The average height of the Sequoia is 300 feet. How many forest trees are over 100 feet in height? A twenty-story skyscraper is an extremely tall building. The Sequoia would look out over the roof of a thirty-story building. With these comparisons in mind we may be able to form a mental picture of a Sequoia—the largest living growth on earth, the only representaties of the giant tree growths of the Miocene Age.

THEIR APPEARANCE.

Perfect specimens, unhurt by running fires, are regular and symmetrical in general form. The immensely strong, stately shafts, with rich, purplish brown bark, are free of limbs for about 150 feet, though dense tufts of sprays occur here and there, producing an ornamental effect, while long parallel furrows give a fluted columnar appearance. The limbs which finally shoot out at right angles from the trunk are themselves great trees, eight and ten feet in diameter. They are more like great sculptured beams supporting the domed head than branches of trees. The rounded appearance of the top of the great trees is always commented upon. No other Sierra tree has foliage so densely packed, or generally rounded outline so faithfully adhered to. The great timbers that start out from the trunks no sooner reach the general outline of the tree than they dissolve, so to speak, into a mass of branches. But the tops of nearly all the old trees have been struck by lightning and great pieces split off. Some trees have been destroyed entirely. They have also been damaged by fire, for up the fluted, furrowed surfaces of the outer bark the fire runs to break into flames on the summit, but it seldom destroys an old tree, though the top is greatly injured.

THEIR AGE.

The great age of some of the still standing trees is one of the most interesting facts in connection with them. Protected by their thick bark—two feet—which fire and insects can not penetrate; by their firm foundation, for their roots are on the same generous scale; with the durable quality of the wood, which never rots, it seems as if nature intended them to stand for ages. It is in recognition of this fact that the name given to the Redwoods—sempervirens, always living—has been bestowed. From some of the



(By courtesy of the Michigan Central Railroad.)

NIAGARA FALLS, THE WORLD-FAMED CATARACT.

Showing the American Fall, Goat Island and the Horseshoe Fall from Prospect Point.

fallen trees we know that the average full-grown Sequoia of to-day is about 4,000 years old. Try and realize what those figures imply. Those trees were growing when Moses stood before Pharaoh; they were in their prime when the Great Prophet of Nazareth taught in the synagogues of Galilee; their branches were waving in the air when Charlemange organized his empire; they were in serene old age when Columbus started on his voyage; their .branches, rounded heads and vigorous forms still excite our admiration.

They ought never to be wantonly destroyed; they should be preserved by every means in our power as mementoes of an earlier age; and yet in the past many have been ruthlessly destroyed, some cut down for lumber, some to make shingles, one was felled for no purpose except to make on the smooth and polished surface of the great stump a dancing pavilion, ample for that purpose, as it was in area over 700 square feet. There is standing at Santa Rosa, California, a large church built entirely of timber obtained from one tree, with abundance left over. It seems almost a sacrilege to convert one of these giant trees into timber to be used for any purpose. Let them stand to remind us of a time when civilization was young, to show us and future generations some of the wondrous growths of former ages. Let us learn from them defiance of time and change.

NIAGARA FALLS

The United States shares with Canada one of the greatest natural wonders in America—Niagara Falls. The Zambesi Falls in South Africa are double the dimensions of Niagara, the falls of the Yosemite Valley are many times higher, but Niagara, taking everything into consideration, the immense volume and steady flow of water, surpass in sublimity any other falls in the world. The Niagara River knows no dry or wet season; its flow is ever the same, draining the Great Lakes of the north and west into the Ontario. As everyone knows, the present falls is divided into two sections by Goat Island, which terminates on the very brink of the falls.

The Niagara River for most of its course from the lake to the falls is a peaceful river, with very little current, on an average about 25 feet deep. The rapids commence a few miles above the head of Goat Island and the descent from there to the falls is 52 feet. Down this decline the waters hurry at a tremendous rate, breaking into foam-crested waves and billows as it approaches the precipice. The American part of the falls is 1,060 feet wide, the height is 160 feet. The depth of water on the American falls is not great. Near the foot of this part of the falls are great piles of rock which fell many years ago. The recession or cutting back of the American falls is slow—only about half a foot in the last fifty years.

The part from Goat Island to the Canadian shore form the irregular curve known as the Horseshoe Falls. This section is 3,010 feet wide, the average depth of the water passing is estimated at 20 feet, and the height of the fall is 158 feet. The great weight of the falling water has excavated a gorge fully 200 feet deep. This part of the falls is rapidly eating back—on an average from four to six feet a year. In the course of a few centuries, then, the location and appearance of the present falls will be greatly different, as when the head of Goat Island is reached the waters will cease to flow over the American side of the present falls.

The gorge below the falls is a true canon, though on a small scale compared to the western canons. The river in the long course of years has eaten back from the shore of Lake Ontario to the present location of the falls. The gorge vies with the falls as an object of interest; it rarely exceeds a quarter of a mile in width, is about 200 feet in depth and in the course of seven miles descends about 100 feet. Consequently, through the narrow gorge the heaped-up waters race at a speed of thirty miles an hour. The channel is obstructed here and there by great rocks against which the current dashes.

The gorge is also of great interest to geologists, and it has been attempted to use it as a gauge with which to measure the lapse of time since the close of the Glacial Age. But there are so many elements in the problem that we do not know that it is useless for that purpose. Not all the water of the Great Lakes has drained down the St. Lawrence since the close of the Glacial Age. Furthermore, a part of the present gorge was probably cut in pre-glacial times, the new channel having been cut from Lewiston back to the old channel at the whirlpool, from which place, making a sudden turn, it had to simply plow out the old glacier-filled gorge for a considerable distance before it began to excavate its present unfinished course. The whole section of country to the east and north of the Great Lakes is gradually rising, though at a very slow rate. Should the present movement continue for another thousand years, the lakes will cease to drain down the St. Lawrence, but commencing near the southern end of Lake Michigan, the waters will resume their ancient course across the prairies of Illinois and down the Mississippi. The roar of Niagara will then be hushed.

THE COMMERCIALIZATION OF NIAGARA.

Niagara being such a great natural wonder, both the Dominion of Canada and the state of New York are united in their efforts to preserve it for the use and enjoyment of future generations, and on both sides state and Dominion parks have been laid out and manufacturing in the immediate vicinity of the falls is forbidden. On the American side some mills and factories that marred the view have been torn down. But this is a utilitarian age. The simple fact is 500,000 tons of water are passing over the falls every minute. That represents a fabulous amount of power going to waste. Perhaps considerable portions could be utilized and not greatly interfere with the beauty of the falls. Accordingly, water has been diverted on both the American and Canadian sides for manufacturing purposes.

An effort will have to be made in the future to properly restrain attempts to utilize too great proportion of the water for the temptation is great to set it to work. The power already produced is used for various purposes; a part is sent to Buffalo by wire and is driving electric cars and turning wheels in busy factories.

FLORIDA

Florida is not exactly one of the great natural wonders of the United States, but it does contain a great many interesting features and is worthy of special notice. Even in its geology, Florida occupies an unique position. It is the only state or portion of the Union that has been built up by the patient labor of minute coral life. Working through millions of years, they built up coral reefs which the waves covered with sand. Repeating the process over and over, and working continually outward, they have formed the peninsula with an area of nearly 60,000 square miles—one of the large states of the Union.

And Florida has had a most interesting political history. Here was the first settlement in what is now the United States. With a few vicissitudes it remained a part of Spain up to 1819 and was the last territory to display the Spanish flag east of the Mississippi River; only seventy-five years ago Florida was the scene of a sanguinary Indian war. In modern days Florida has become a great pleasure resort. The eastern shore from St. Augustine south is now known as the American Riviera. A railroad has been built for almost four hundred miles along the east shore, and then by most remarkable engineering it stretches away on a concrete built causeway, linking up low-lying keys and finally entering Key West. It is the most peculiar railroad in the world. It is the opposite of the canon-built roads of the West. And along the east shore are some of the most famous pleasure resorts in the world, and pre-eminent among them is Palm Beach.

PALM BEACH.

On one side is Lake Worth, on the other the Atlantic, and over the stretch of sand between are groves of cocoanut palms and palmettoes, avenues of Australian pine and oleanders, and gardens of gloriously hued flowers. There is a chain of hotels of a size, equipment and beauty, not surpassed in any part of the world; road, bicycle trails and bridges have been built, and the whole region has been converted into a pleasure resort on a scale never before attempted. Nature has supplied the raw material, but human science and a lavish outlay of money have arranged them. The result is a delightful union of primal beauty and up-to-date comfort. Shell roads, gleaming white, lead through tangled thickets of live oak and palmetto, and other semi-tropical foliage, with scarcely a sign of human habitation for miles together. At Palm Beach the miles upon miles of carefully graded walks lead through gardens where roses bloom throughout the winter months and a bewildering profusion of every variety of foliage is banked solidly on either hand; through avenues of cocoanut palms drooping low above the waters of Lake Worth, past gardens where oranges and lemons shine among the green leaves; far into the depths of the untrained jungle, where the winding way carries one through a solid bower of greenery, through which even the midday sun can scarcely send his rays.

INDUSTRIES OF FLORIDA.

Of all the industries of Florida, the one for which the state is most renowned is the growing of fruit; wherever semi-tropical

SPONGE FACTORY—KEY WEST, FLORIDA.

An important industry about which few people are informed.

fruits are eaten the name and fame of Florida is known. The list of fruits grown is so long that we can name only the more important ones. Of course, oranges head the list, but other fruits—such as lemons, pineapples, bananas, grape-fruit and citrons are raised in great abundance. The cultivation of pineapples is increasing very rapidly, and thousands of crates of that fruit are shipped from the east coast towns every day during the season. The pineapple is a fruit that must be protected from too ardent rays of the sun by lattice work.

LUMBER INTERESTS.

It comes as a surprise to many to learn that fruit raising is not the most important industry of Florida. The northern, central and western portions of the state are covered with pine forests. Especially is this true of the tier of counties ending in Pensacola. That city is one of the most important lumber ports in the country, shipping every year many million feet. And also it surprises many to learn of the vast mining interests of Florida. The mineral mined is phosphate rock, one of the most valuable fertilizers known. There are inexhaustible supplies of this material in the western half of the state.

THE SPONGE FISHERIES.

The Florida Keys are the only sponge fishing grounds in the United States, and a large fleet of vessels is occupied in this industry; the yield is far from supplying the demand for sponges, hence the market is always active. Key West is the center of this industry, and upon the wharf which serves as the sponge market of the city may be seen the agents of various wholesale houses, from different sections, endeavoring to secure their share of the product. The United States government is fully alive to the importance of this industry, and its agents are studying means to conserve present supply and extend the range of growth. Take it all in all, Florida, with its interesting history, its extensive pleasure resorts—the most beautiful in the world—its luscious fruits and other great industries, is certainly one of the most interesting parts of the United States.

DAKOTA WHEAT FIELDS.

LATIN AMERICA

The Rio Grande River, between the United States and Mexico, is the dividing line between the area of Spanish and English influence in the New World. From that river south to Cape Horn, thus including all of South America, with the exception of Guiana, belonging jointly to Great Britain, the Netherlands and France, is the location of seventeen independent republics.

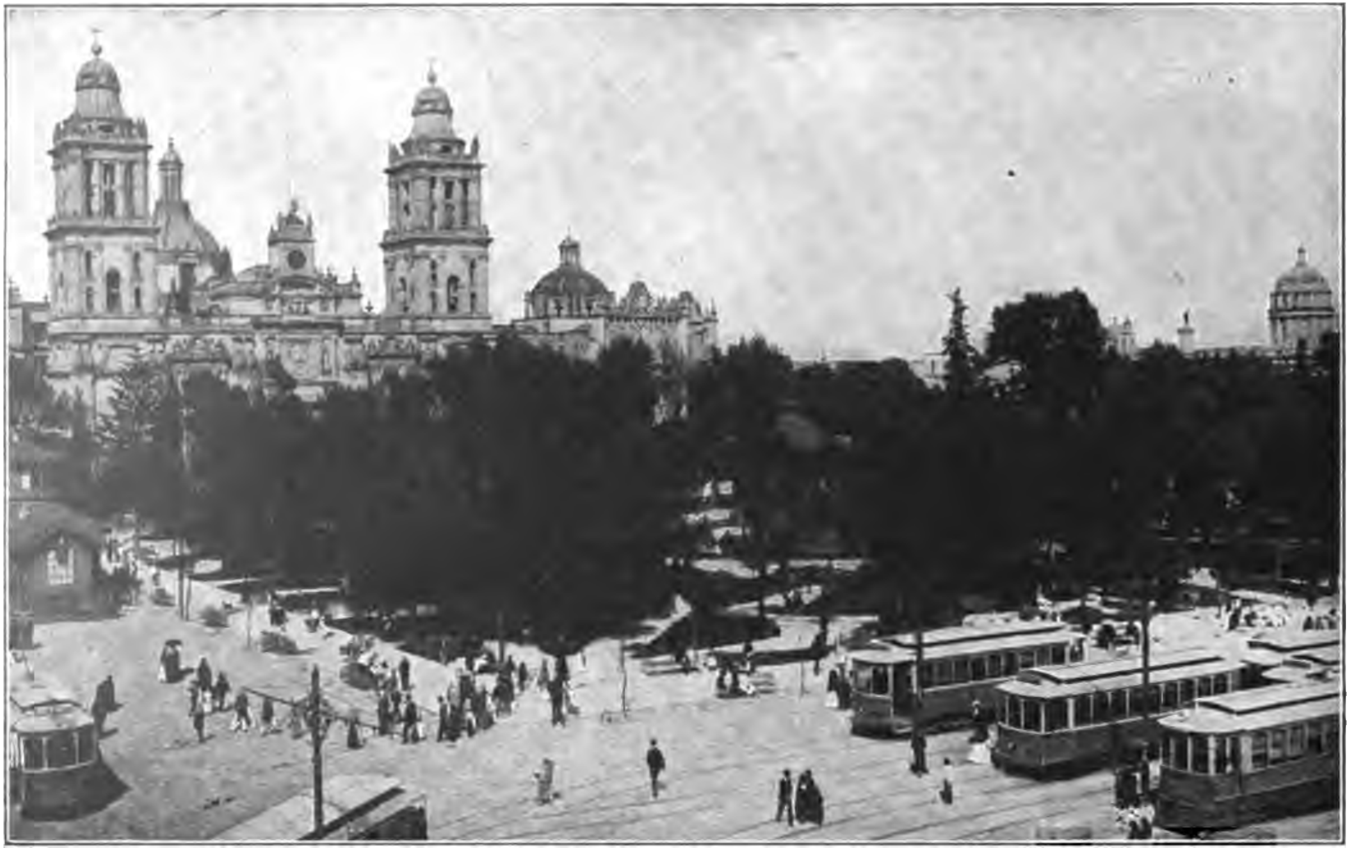
Language is not the only difference between these sections of the New World. The dominant chords of social, political and religous life are pitched to different scales, and it is difficult for the people in one division to enter fully into the psychic world of the other. Collectively, this part of the New World is known as Latin-America, because the dominant people have always been of Latin extraction. The political institutions of the two sections of the New World are on the same lines and need not be mentioned in detail. But there are many interesting facts about Latin-America that should be better known.

North America, to the south of the Rio Grande, is the home of seven republics. The combined area of the seven countries is 973,524 square miles. Few realize that is an area as large as all the United States east of the Mississippi River and in addition, Minnesota, Iowa and Missouri to the west of the river. The combined population of the republics is 19,886,000, but that is only about twenty-seven per cent of the population for the equivalent area in the United States. Mexico is the largest and most important republic, having an area of 767,097 square miles, and a population of 16,000,000. Salvador, with an area of 7,325, is the smallest, but it is densely populated, having 232 to the square mile, a rate exceeded by only four states in the United States. Salvador is also the only one of the republics which does not front on the two oceans. Mexico has 16,000 miles of railroads, but there is less than 1,500 miles in the remaining countries. Of these republics, Panama stands in special relation to the United States, since by the treaty securing the Canal Zone we guaranteed the independence of the country.

In 1918 the foreign trade of these republics was $3,037,722,942. This trade is, however, growing, in normal times increasing about $20,000,000 yearly. All are agricultural countries, except Mexico, which is a mining country. There is considerable mining in Honduras as well. Of the agricultural products, coffee and bananas are the staples. Though all these republics are in the tropics, yet as most of them are mountainous, the climate is good, the heat not excessive, the rainfall sufficient, and the soil fertile in most sections. There is no reason why the future should not bring increasing prosperity to that entire section. A far greater population can be supported, except in Salvador. The fruit and coffee industry is becoming more and more important. The export of bananas is assuming very large proportions.

MEXICO.

Mexico, on the southern borders of the United States, is easily the most important of these seven republics. It has been in a



Courtesy of the Pan-American Union

THE CATHEDRAL, MEXICO CITY, MEXICO.

This gothic structure is the most conspicuous feature of the architecture of the metropolis, occupying the site of the old Aztec war god and covering one entire side of the Plaza Mayor, in the heart of the capital. Nearly one hundred years were spent in its erection, and it was not completed until 1667, at a cost of $2,000,000.

deplorable condition politically, but when conditions in that respect improve, the country should advance very fast. In normal times the value of the gold and silver mined is nearly $100,000,000 yearly. About 60,000 tons of copper and twice that amount of copper ore are also produced. Nearly all the chicle from which chewing gum is made comes from Mexico, about 3,000 tons yearly. We must not forget that Mexico is a very large country. In area it is as large as all east of the Mississippi River in the United States, excepting only Connecticut. Its population, however, is only one-fourth as great. If placed on the map of the United States, its longest direction would reach from Puget Sound to New Orleans. It is mountainous and every variety of climate is to be found. There are over 6,000 miles of coast line, with ten harbors on the Atlantic and Caribbean Sea side and thirteen on the Pacific side. Education is making great progress. With the return of peace, there will undoubtedly be a great development of all industries.

Courtesy of Pan-American Union.

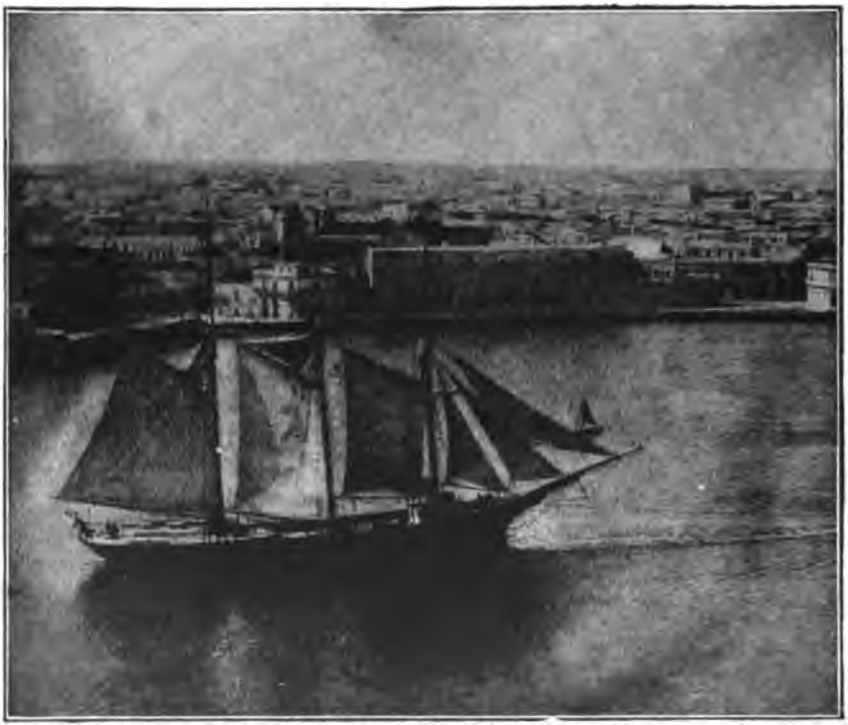
THE OLD CITADEL AT THE MOUTH OF THE OZAMA RIVER, SANTO DOMINGO.

The entrance to the harbor and the historic fortress with its commanding position are strangely reminiscent of the romantic history of he Spanish Main, around which are closely woven thrilling stories of buccaneers, of freebooters, and of buried treasures.

The capital of Mexico is described as one of the most beautiful cities in the world, and it is the oldest in America, as it was a flourishing city when Cortez landed in Mexico. There was the center of the Aztec Confederacy, and in the province of Yucatan was the seat of the Maya civilization, which had probably passed its zenith of culture long before the discovery of America.

THE ISLAND REPUBLICS.

There are three republics of the Latin-American group in the West Indies, Cuba, Haiti and the Dominican Republic. The two latter republics divide between themselves the island of Haiti, with a total area very nearly the same as that of Maine. As a matter of interest, it might be remarked that French is the language of Haiti.



Courtesy of Pan-American Union.

SCENE IN HAVANA HARBOR, SHOWING A SECTION OF THE NEW WATER FRONT.

The island of Cuba is an independent republic. Its area is 44,164 square miles, very nearly as large as Louisiana; its population, however, 2,383,000, is half again as large as that of Louisiana. It is a republic with a future. During eight-ninths of the year the climate is ideal. It is a densely settled agricultural country, with a very extended coast line with numerous excellent harbors. Cuba leads the world in the production of cane sugar, exporting in 1914 about 2,500,000 tons of raw and 20,000 tons of refined sugar. It does not produce as much tobacco as the United States, but it grows the very finest quality, and has almost a monopoly in the production of very fine cigars. Since it acquired its independence in 1898 it has advanced very rapidly. As a rule, its soil is fertile; it contains numerous mines of valuable metals, forests of great extent and value. Under the guiding hand of the United States, its government has become stable, education is compulsory, and the republic is situated right in the track of the great tide of future commerce to and from Panama, and its prosperity seems assured.

SOUTH AMERICA.

South America is known as the continent of opportunity. All of the continent except that part known as Guiana is the location of ten independent Latin-American republics. Their combined area is 7,342,235 square miles, or a little more than twice the area of the United States and Alaska. The largest republic is Brazil, with an area about 300,000 square miles less than the combined area of the United States and Alaska; the smallest is Uruguay, with an area nearly as large as Arizona. Besides Brazil, there are four other republics—

Courtesy of Pan-American Union.

AVENIDO RIO BRANCO, RIO DE JANEIRO.

Argentina, Bolivia, Colombia and Peru—each of which exceeds in area the original thirteen states of our Union, with Idaho thrown in for good measure. Bolivia and Peru are each nearly as large as the territory east of the Mississippi, while Argentina would require Minnesota, Iowa and South Dakota in addition to the territory east of the river. The combined population, however, is but a little over one-half the population of the United States, the population per square mile being less than eight. There is room for a vastly larger population, since proportionately there is not more waste land than in the United States.

Courtesy of Pan-American Union.

THE AMAZON FOREST.

BRAZIL.

In area, Brazil is as large as the United States, France and England combined, 3,292,000 square miles; but its population per square mile is less than one. It could support a vast population. Brazil is further distinguished by having been originally a Portuguese possession, and the language today is Portuguese. Its longest direction north and south extends over 38 degrees of latitude, and the same number of degrees of longitude, east and west. At some point of its extensive boundary it touches every other country in South America except Chile. It lies entirely within the temperate and tropical zones, but the climate of a considerable area is modified by numerous high table lands and mountain chains, as well as by its mighty rivers.

Courtesy of Pan-American Union.

THE MILITARY ACADEMY AT CARACAS, VENEZUELA.

THE AMAZON RIVER.

This is the mightiest river in the world. It is 100 miles wide at its mouth and hundreds of miles from its mouth it is too wide to see across. Ocean-going steamers can go as far up that river as from New York to Kansas City. The Amazon, taken in connection with its numerous navigable rivers, gives Peru an inland water system not surpassed by any other country in the world, though it traverses for much of its way what is at present a tropical jungle, inhabited by tribes of native Indians, as wild and uncivilized as when the first Portuguene navigator skirted its shores 400 years ago. It is, however, a country with a future, for it has immense natural resources. Its vast supplies of valuable timber are as yet almost untouched. There are only 15,000 miles of railroad, but an era of railroad building seems close at hand. Brazil is spending $100,000,000 in improving her ports and building railroads to connect her distant provinces, each a possible empire in itself. Its agricultural possibilities are on the same immense scale as those of the United States. The great export articles are coffee and rubber. In modern life, rubber is becoming a prime necessity. Brazil exports nearly 50,000 tons of crude rubber yearly. Rubber is not the product of any one particular tree, but is obtained from a number of different trees, plants and shrubs. About one-half the world's supply of rubber comes from Brazil.

THE CULTURE OF TAPIOCA

Tapioca is probably a native of Brazil, but is also largely cultivated in Peru, Guiana, Venezuela, the West Indies, South India and Malaysia. The bitter kind, which is more productive than the sweet species, is propagated by cuttings from the ligneous part of the stem, planted in rich, dry soil. The tubers are ready for digging up in from six to twelve months, according to the variety.

There are two modes of preparing the starch. In the wet method the grated root is placed in water for about five days, then kneaded with water, and pressed to extract the juice. The fecula is sifted and baked in earthen ovens, some fresh manioc paste, which has fermented being always added. In the dry process the root is rasped by hand, and, after adding water, is pressed; after drying and sifting it is baked. The fecula deposit is washed three times and sun-dried. The collected starch, heated on iron plates, becomes partially cooked and agglomerates in small, hard, irregular lumps, constituting tapioca.

The culture of tapioca is inexpensive and the product is highly remunerative, so that the growth of the plant is becoming very general throughout the tropics.

TAPIOCA PLANTATION.

Malayan, Peru

Courtesy of Pan-American Union.

THE PASSEIO PUBLICO, RIO DE JANEIRO.

Just beyond the south end of the Avenida Rio Branco, and where it makes a graceful turn into the Praia de Lapa, is a public park. It is heavily wooded, with winding walks, an aquarium with native fishes, and popular attractions of like nature.

Courtesy of Pan-American Union.

A SCENE IN THE BOTANIC GARDENS, RIO DE JANEIRO.

The botanic gardens in Rio are well worth a visit to see the interesting collection of tropical plants so well taken care of there. A novelty to North American eyes is the huge Victoria Regia, the pond lily of the Tropics.

COFFEE.

The coffee crop in Brazil is becoming more and more its principal article of export. The yearly crop is about 12,000,000 sacks of coffee, and each sack contains nearly 133 pounds. A natural coffee plant grows about 18 feet high; it has a slender trunk without branches on its lower part. No more beautiful sight can be imagined than a great coffee plantation during the flowering season. The trees cover the hills and table lands and the air is heavily laden with a delicate fragrance. The trees blossom most heavily in October, and the crop is harvested in May; each tree yields about four pounds of coffee. When the berry is ripe, all other work on the plantation is dropped, and every available person engages in the harvest. Four-fifths of the world's supply of coffee comes from Brazil, and more than half of that from the state of San Paula.

RIO DE JANEIRO.

The harbor of Rio de Janeiro is claimed to be the finest in the world, and the city itself is called the cleanest in the world. It has a population of 1,500,000. There are only three cities in the United States larger than that. The principal avenues through the heart of the city are lined with massive buildings, and Rio de Janeiro has expended more money in the last ten years in public improvements than any city in the United States except Chicago and New York.

Courtesy of Pan-American Union.

SCENE NEAR BARRANQUILLA, COLOMBIA.

Barranquilla is the chief port of entry of Colombia and is a progressive city of over 50,000 inhabitants.

COLOMBIA.

Colombia has a coast line on the Pacific of four hundred miles, and an area as large as Texas, Kansas, Arkansas and Louisiana combined. It has a population of only about ten to the square mile, yet it is a country of fine rivers, lofty mountains and fertile valleys. The Cauca Valley is said to be one of the most fertile sections in the world. It is larger than the state of New Jersey. Colombia is a country abounding in undeveloped gold mines, has immense coal fields, and possesses rubber in exhaustless quantity. It also has the only emerald mines in the world, and thousands of square miles of fine timber, and numerous waterfalls ready to furnish electricity for manufactories. Thus at the very edge of South America is a great nation as yet undeveloped, with fertile valleys and treasure-burdened hills.

Courtesy of Pan-American Union.

LLAMAS IN THE HIGH ANDEAN REGIONS OF PERU.

ECUADOR.

Ecuador is appropriately named after the equator, which cuts across the country. It is a small republic, yet it includes an area about as large as Missouri and Arkansas combined. At present it has a population of only about thirteen to the square mile. But it has fertile provinces, producing cocoa, coffee, rice, sugar cane and all kinds of tropical fruits. It has numerous mines, rich forests of excellent timber, rubber trees and vegetable ivory. It has mines of coal and copper awaiting development. Textile plants grow in the mountains. The low country produces cotton and vegetable silks of excellent quality, and everyone knows that Panama hats are made in Ecuador. Its great port is Guayaquil, a city of sixty thousand people, and it constitutes the great doorway to the country. About one-third of all the chocolate we use passes through Guayaquil.

PERU.

Peru is a republic as large as all our Southwest—Texas, Nevada, Utah, Arizona and New Mexico. It has a forbidding coast line of fifteen hundred miles on the Pacific. Its population is only about seven to the square mile. Yet it is a country of great possibilities. Here was the center of Inca civilization, the highest native culture in the

New World; a country whose wealth excited the cupidity of Pizarro; the fate of whose native population is one of the most pathetic chapters in history; whose gold and silver filled to overflowing the depleted coffers of Spain; whose capital city was the seat of the most powerful vice-royalty in the New World; whose university was attended by a thousand students a hundred years before Harvard opened its doors.

The stretch of desert land which borders Peru on the Pacific coast is but an unpleasant fringe of the rich coverlet which overlays all the republic. Peru is a vast treasure house. It stands as the third richest country in the world for its natural resources. In the hot lowlands along the coast cotton and sugar cane are growing; in the plateau region, wheat, corn and barley. The slopes of the foothills furnish unlimited pasturage, which are now practically unoccupied. There is room in Peru for millions of settlers. Most of the desert tract along the coast could be irrigated, and that once done, it would become a region of great fertility.

Courtesy of Pan-American Union.

A MINING PROPERTY NEAR LAKE TITICACA, PERU.

THE CINCHONA TREE IN PERU.

Several species of the cinchona tree are indigenous to Peru, and from the bark of one of them is extracted the widely known alkaloid called quinine.

The cinchona tree grows to a medium height and is bare of branches and foliage except at its tip. The natives climb the trunk, which is very smooth, and shave off the bark with knives.

The tree derives its name from the wife of Count Chinchon, viceroy of Peru in the seventeenth century, who by its use was freed from an intermittent fever, and after her return to Spain, contributed to the general propagation of this remedy.

BOLIVIA.

This is a country so vast that we could put into it our states of Washington, California, Utah, Idaho, Arizona and Nevada; yet such is the sparseness of population that it averages only about three to the square mile. But Bolivia is a country of vast possibilities as well as size. Its different climates at varying altitudes make every agricultural product possible, while its mountains contain every known mineral. The possibilities of live stock raising on its uplands are becoming recognized. It has mines of silver and gold waiting modern machinery to be among the most valuable in the world. There are many abandoned silver mines that could be profitably worked by modern methods. In addition, there are mines of copper and zinc. Bolivia supplies a quarter of the world's output of tin, and the production can be easily increased. Tin is a metal that sells for a thousand dollars a ton, and the mines of Bolivia are strung along for hundreds of miles. This alone furnishes the background for an alluring future. In many places the mineral is more than fifty per cent pure.

Courtesy of Pan-American Union.

IN THE MINING DISTRICT OF SOUTH AMERICA.

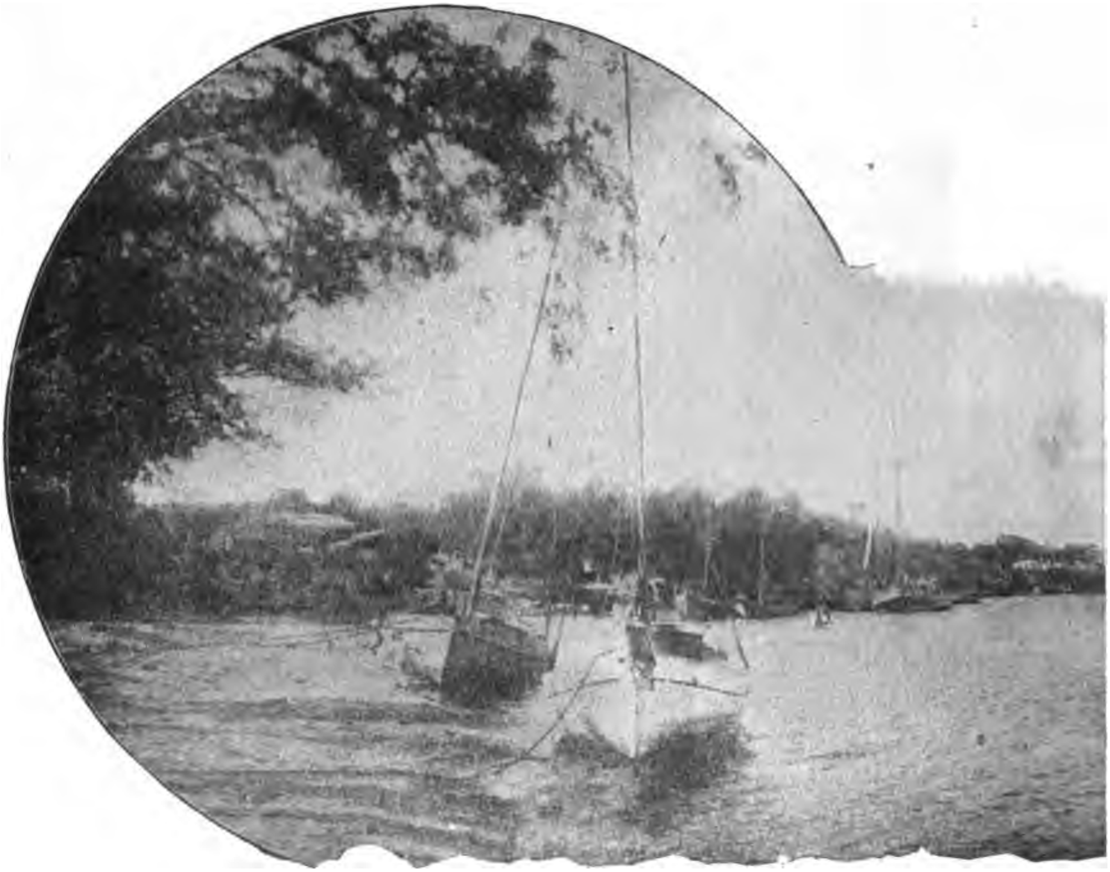
The richest mining region of the country is that inclosed by the two great branches of the longitudinal Andean Cordillera. Both of them contain an abundance of all classes of minerals. So free is nature in her gifts that instances are not infrequent where gold-mining companies are assisted in their operations by coal extracted from beds in close proximity to the deposits of precious metals.

CHILE.

Chile is in many respects the most interesting of the Pacific coast republics. It has a coast line of twenty-five hundred miles, but an average width of only about a hundred miles. In area it is about as large as California and Montana combined. Its population is about twelve to the square mile. It is evident that here also is room for millions of industrious settlers. Its great port is Valparaiso. Its capital is Santiago, something over one hundred miles distant, situated in the midst of a fertile plain. It is by far the finest and most prosperous city in the west coast section. It has great municipal buildings, an imposing cathedral, tree-lined streets, and flower-decked parks. Santa Lucia is the most beautiful city breathing-place in all the Americas.

Its central valleys are rich in agricultural products. In the southern part of the country are abundant forests. But the great source of wealth is the immense nitrate beds in the northern provinces. Nature has here deposited the best fertilizer known. Japan, large sections of the United States and Europe are making more and more use of Chilean nitrates to sustain the fertility of their land. Europe takes about one million tons a year, the United States takes about three hundred thousand tons. In the future nitrate shipments will double and treble.

There need be no fear of exhausting the deposits. The desert coast region of north Chile, where rain never falls, where every supply for man and beast has to be brought from other sections, where even the water used by the workmen has to be piped in from the mountains, two hundred miles distant, is the richest section of Chile. The deposits extend up and down the coast for



Courtesy of Pan-American Union.

PUERTO DE ESQUINA, IN NORTH ARGENTINA, NEAR THE CONFLUENCE OF THE CORRIENTES AND PARANA RIVERS.

hundreds of miles. In some places they are three and four miles wide. There are hundreds of millions of tons, enough to supply the world for centuries, at the expiration of which time mankind will be able to draw its nitrogen supply from the air.

Courtesy of Pan-American Union.

A SKYSCRAPER IN BUENOS AIRES.

It is said that this building is the first skyscraper in South America. It is on the Paseo Colon, not far from the Plaza Victoria and the Government Palace, near the customhouse and the large docks. In this neighborhood are the warehouses of big business, and stepping across the Paseo one may see in all its activity the tremendous commerce, both local and foreign, passing in and out of Buenos Aires.

ARGENTINA.

Argentina is one of the large republics of South America. Its area is 1,153,418 square miles. Few realize that it is a territory as large as all the United States east of the Mississippi River and in addition all the states bordering the river on the west, or that if placed on the map of the United States, its longest direction would reach from Washington to Tacoma. The country presents every degree of climate from tropical in its extreme northern part to frigid in southern Patagonia and Tierra del Fuego. In the extreme north, near Bolivia, the country is heavily wooded, but in the center and southern plains it is open, and on the west, towards the Andes, it is rolling and broken. About 400,000 square miles are suitable for agriculture.

The population of the country is about 9,000,000, or only about one-eighth of the population of the equivalent area in the United States. The capital city, Buenos Aires, is one of the world's great cities, approaching 1,500,000 in population and growing rapidly. It has beautiful streets, many stately buildings, and only New York, Chicago and Philadelphia exceed it in the amount spent for public improvements. In all, Buenos Aires is a fitting metropolis for the south. The country is developing very rapidly. The total foreign trade increased nearly 100,000,000 yearly for the last few years. The central provinces are well supplied with railroads, 21,000 miles in all. One of their lines is connected with Valparaiso, Chile, by a notable tunnel under the Andes, so that it is a matter of only a day and a half's travel between Buenos Aires and Valparaiso. Wheat and corn are the principal crops. Beef and mutton are exported in large quantities, and within the last year cargoes of frozen beef from Buenos Aires have been laid down in New York at a profit over beef from the packing-houses in Chicago.

Courtesy of Pan-American Union.

GRAIN ELEVATORS OF BUENOS AIRES.

Although the present immense facilities for shipping of Argentine commerce are greater than had been proposed a few years ago, yet they are not now extensive enough to accommodate the foreign commerce passing through the port. The city has found it necessary to enlarge it docking space, and the Government is hastening the improvements at such important ports as Rosario and Bahia Blanco.

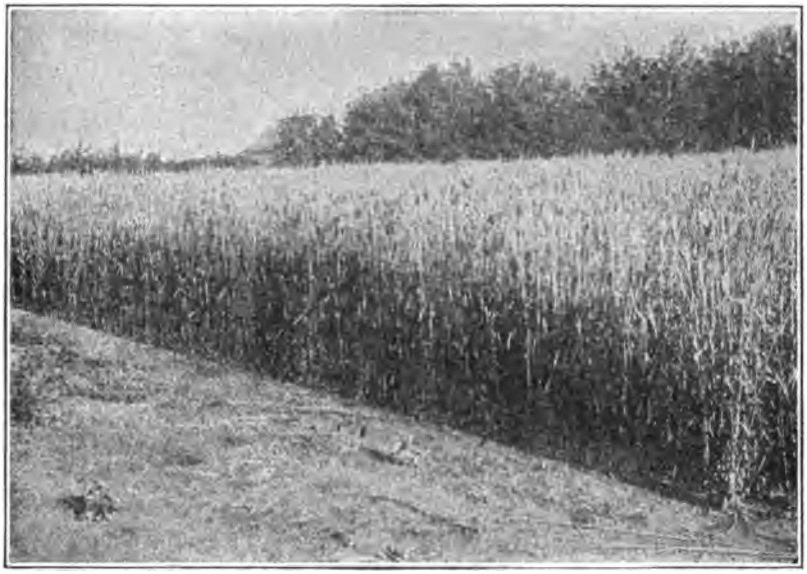
PARAGUAY.

Paraguay is one of the inland countries of South America, Bolivia being the other. It is one of the smaller countries of South America, with an area of only 196,000 square miles, and yet that is an area nearly as large as all of New England, New York, New Jersey, Pennsylvania and Ohio, but its population is less than five to the square mile. It could easily support a far larger population. The climate is subtropical, much of the country is level and prairie-like, though for the most part it is heavily wooded. The Paraguay River flows through the center of the country, and the part to the west of the river is called the Chaco. It is now low lying and swampy, but extensive areas are suitable for cattle raising. This part of Paraguay is very thinly settled.

Agriculture and stock raising are the principal industries, and it is said that there is no better cattle land in the world than the prairie lands of Paraguay, but as yet that industry is only just beginning. Fruits and particularly oranges grow in the utmost luxuriance. It has been said that oranges are more common in Paraguay than acorns in Pennsylvania, and as a rule they are almost as cheap. There is a short railroad of 232 miles from the capital to Encarnacion on the upper Parana, where it connects with the Argentine system and through train service to Buenos Aires has been installed. But the principal means of communication with the outside world is by the Paraguay and its numerous branches.

URUGUAY.

The smallest of the South American republics, having an area of 72,210 square miles, but that is larger than all of New England. Uruguay has some advantages over some of the larger republics. No other country has such a uniform climate over its entire area. Nearly all the land is arable and the country is well watered by innumerable streams. Being within the south temperate zone, it is subject to neither extreme heat nor cold. The summers are about like those of Virginia, but the winters are much milder. There is a good rainfall, and most of the country is open, rolling and somewhat prairie-like. In few countries can inland transportation be carried on by water so easily as in Uruguay. Almost every



Courtesy of Pan-American Union.

A WHEAT FIELD IN ARGENTINA.

Immense amounts of wheat are raised in that country.

plantation owner in the country is in direct communication with Montevideo, the capital, by means of the network of natural waterways. There are, however, 1,600 miles of railway in the country. In the future, in proportion to its area, it will doubtless be one of the greatest grain-producing countries in the world, but at present Uruguay is one great cattle range.

Courtesy of Pan-American Union.

VIEW OF CARACAS, VENEZUELA, LOOKING TOWARDS THE MOUNTAINS.

VENEZUELA.

The remaining republic in Latin-America is Venezuela, with an area of 393,976 square miles. That is an area as large as all the states of our Atlantic seaboard from Maine to Florida, including Pennsylvania in the list. Its population is given as about 3,000,000, though the figures are very doubtful. In the north, near the ocean, are three distinct mountain ranges with elevated plateaus between them. In this section the climate is mild and equable. The extensive plains and river valleys of the south and west are known as the Llanos. The climate of these parts is tropical. The country bordering Brazil on the south is heavily wooded and the only inhabitants are wild Indians.

There are about 600 miles of railroad, all short lines, running from the ports into the interior. Agriculture is the principal industry, and coffee and cacao are the principal products. All the principal minerals are found. Petroleum is known to exist in very large quantities, and all know that Lake Bernendez is the source from whence about 100,000 tons of asphalt are taken yearly.

LATIN-AMERICA IN GENERAL.

Latin-America is the oldest settled section of the New World. Before St. Augustine was founded cities had been built here and there throughout that vast section, from Mexico on the north to Buenos Aires on the south. And all through the seventeenth century, when a fringe of settlements were struggling for existence along our eastern seaboard, a veritable tide of gold and silver was flowing from Peru and Mexico across Panama to Spain. All Latin-America declined in importance with the decline of Spain in power and influence; but the long night of its decadence is now past. That whole section of the New World is responding to modern life. There is not a republic we have passed in review that is not at the dawn of a better day. A time of development is at hand. Undoubtedly, the next fifty years will witness a growth in Latin-America in general that will parallel the great development of Germanic North America in the nineteenth century.

THE BRITISH EMPIRE

Though the various portions of the British Empire are held together by rather loose bonds, they constitute a gigantic whole, the greatest empire ever known in history. Few, even the well-informed, understand the immense area included in that term. There is not a large division of the earth that does not include large sections belonging to the British Empire. Her naval stations are to be found in every sea.

What we call the United Kingdom, meaning thereby England, Scotland, Ireland and Wales, is only the heart, the nucleus of a mighty organization which is world-wide in its sweep. The following figures give us the area of the different constituent parts of the British Empire:

Country	Area	Population
The United Kingdom	121,391	45,652,741
European possessions	119	234,972
India	1,773,088	315,086,372
Rest of Asia........	166,835	8,478,700
Australia and Pacific islands	3,192,677	6,229,252
African possessions..	2,233,478	35,980,913
American possessions	4,011,037	9,516,015
Total............	11,498,625	421,178,965

POLITICAL DEPENDENCE AND LOCATION.

The bonds which unite these different countries to the United Kingdom are diverse. Some are merely crown colonies like Gibraltar in Europe. Such colonies are entirely controlled by the home government. In other colonies the home government simply appoints a governor, in some cases retaining control over public officers; in others, such officials are responsible only to the colony. Some possessions are merely dependencies; others, like the Dominion of Canada, the Commonwealth of Australia, the Union of South Africa, are independent countries, though the home government appoints the governor general. India is in a class by itself. Large parts of Africa are styled protectorates, as the Uganda Protectorate. That is to say, the country is nominally under the rule of native kings, etc., but in reality, under the rule of a British governor. The nature of the occupation in some cases, like Weihaiwei in China, is disguised by stating that it is leased to Great Britain, but the lease will only be canceled when political decline overtakes the empire itself. The extensive territory in North Africa, Egypt and Anglo-Egyptian Sudan, a combined area of almost 1,400,000 square miles and a population of about 9,000,000, is not included in the foregoing lists as part of the British Empire but as one of the results of the world war they now form a part of that far-flung empire. A still further change seems impending. Turkey will no longer

TRAMWAY IN THE BRITISH POSSESSION OF HONG KONG.

be allowed to exercise authority over the non-Turkish provinces of Western Asia. Just what the conditions will be in those sections can not be determined at present; but it seems certain that Great Britain will assume control over a large part of ancient Mesopotamia. Relieved from the terrible curse of Turkish oppression and misrule, we may expect to see those sections once more prosperous. We must not forget that Mesopotamia was once the seat of mighty empires and vies with Egypt in being the home of early civilization, long before Southern Europe had caught the glow. It is indeed fortunate that these cradle lands of culture should pass into the secure possession of Great Britain. Already great improvements are noticed in Egypt. Few realize the wondrous wealth of natural resoures awaiting development in Mesopotamia. Once again on Shinar's plains may prosperous cities rise.

Speaking in general terms, it will be noticed that the British Empire includes in its bounds one-fourth of the total land area of the globe and fully one-fourth of its population. Counting in Egypt and the Anglo-

Egyptian Sudan, we notice that the African possessions are larger than those of any other of the grand divisions of the world. The Dominion of Canada is the largest single contiguous portion of the empire. India contains by far the greatest number of inhabitants of any part of the empire, but the population per square mile in the United Kingdom, 375, is more than twice what it is in India. About 40,000 square miles of this area is composed of archipelagoes, the most extensive being in the Pacific Ocean, the most important is the West Indies. Some isolated Islands are of great historic interest, as St. Helena in the Atlantic, Malta and Cyprus in the Mediterranean. It is also interesting to recall that more of this extensive area is in the southern hemisphere than in the northern. Finally, as the United States has one ocean canal passing through its territory, we should note that the other great ship canal, Suez, passes through what is virtually territory of the British Empire.

THE GOVERNMENT OF GREAT BRITAIN

The abuses to which the thirteen original American colonies were subjected by the British crown caused the Revolutionary War, and impressed a deep-set opinion of the absolutism of the British government on the minds of many Americans.

HOUSES OF PARLIAMENT AND WESTMINSTER ABBEY.

It is a fact, however, that with all the pomp and ceremony of royalty, the government of Great Britain is one of the most liberal in the world. It is monarchical almost in name only, for although the crown of England passes to the oldest member of the reigning family, and with it the sovereignty over all the British Empire, yet its power is limited so that the monarch cannot use coercion on subjects without great risk of revolution and dethronement.

FATE OF CERTAIN EARLY MONARCHS.

Although the government is a limited monarchy, it is almost a democracy, built upon an unwritten constitution of customs and on a parliament of two houses—the lords and the commons. These working through a cabinet and influenced somewhat by the king, carry out ultimately the will of the people. The constitution is the outgrowth of centuries of struggle between parliament and the monarchs. In early times, the rulers were practically absolute, but when some of the more cruel ones were deposed, executed or judged insane and regents were appointed in their places, the people gradually acquired rights which they guarded jealously, and never permitted to be lost. Charles I. was deposed, and for a time Oliver Cromwell, as president of the great Commonwealth, governed in democratic form. Then came the monarchy again, but as soon as James II. attempted to become an absolute monarch, he was deposed and William and Mary succeeded. Since this time, the cabinet has played an important part in the government of Great Britain. At the time that George I. came to the throne, from a German family, he did not understand English, and, naturally, the cabinet was his mainstay. George III. tried to do away with this institution, but the people's action finally brought him back to using such advisers, and since then the cabinet has become a permanent fixture, though not mentioned legally as such, being simply the outgrowth of custom.

THE CABINET.

The cabinet is a body made up of from 15 to 20 of the chief ministers of the several portfolios or departments of the government. In order that this system of cabinet government may work out most effectually, two rival parties are presupposed. Each party, criticising the acts of the other and striving for supremacy, keeps the other on its mettle. The ministers of the cabinet naturally belong to the party in power. Thus they control the situation well enough to pass any measures the administration may propose. When, through waning popularity, poor government, or for any similar reason, the cabinet party lacks sufficient support to pass its measures, it resigns the cabinet positions. There is the alternative of appealing to the public in elections. If recourse is had to this method, the house of commons is first dissolved. If the members are returned by vote of their constituents, the administration is vindicated, and the bill in question is passed. The house of lords can not directly veto an act passed by the commons; but they can delay its passage for two years, then, if the commons persist in its passage, it becomes a law without the lords' consent.

From the foregoing it may be seen that the house of commons directly represents the people, and that when it comes to appealing to the public at large in regard to measures that receive universal support, it surpasses the house of lords in power. In like manner it can be understood that the monarch, in order to be in perfect accord with his people, must coincide to a great degree with this branch of parliament.

As before said, the cabinet is not recognized by law, but is the outgrowth of custom, its origin having been a secret body of advisers of the crown. Naturally, in the beginning, the more powerful party in parliament was sought out by the sovereign to aid him in securing legislation. The cabinet of to-day, therefore, resigns when it no longer has the support of parliament, and thereupon the king calls to his aid the leaders of the opposite party. These he appoints to the ministerial offices (the privy council) and from them he selects his cabinet. This body has no authority save in that they are members of the privy council, and the premier who, also, is not recognized by law as such, gains his authority through being a minister, generally, the minister of foreign affairs.

THE JUDICIARY.

The judiciary holds office for life and cannot be removed except for cause. Thus, in the main, its acts tend toward justice. It is entirely separated from the legislative and executive departments of the government, although to some extent it is appointed. Should it interpret laws adverse to the wishes of parliament, that body would enact new laws which would nullify its decisions. The house of lords is a hereditary body. It has almost co-ordinate power with the house of commons, save that it cannot introduce or amend financial measures. The privy council is the official body that confers with the ruler and signs enactments. The king makes formal appointments, and the cabinet must have the support of the majority of parliament to hold office. Thus the commons, which is the most numerous body, may be said to choose the cabinet. When a new parliament is chosen, the public, practically, chooses the new prime minister, for it has the leaders of the opposing party in mind when casting votes. All acts must be performed in the light of publicity, to gain favor, because there are two parties.

EFFECT OF THE WORLD WAR ON THE BRITISH EMPIRE.

An analysis of the foregoing shows that before the world war Great Britain formed one of the most democratic governments of the world. The King of England exercised far less power than the president of the United States. He is simply the official head of the empire but in no way does he influence legislation. All power resides in the people, expressed through the House of Commons. And then came on the great war and Great Britain promptly arrayed herself on the side of democracy against autocracy. In the clearer light of the present we see that England and Germany were on the whole the foremost European representatives of the two antagonistic systems of government which met in a life and death struggle in that war. What we should consider is the effects of that war on present conditions and future prospects of the empire.

STRENGTHENED UNITY WITHIN THE EMPIRE.

The war greatly strengthened the ties that bind the many provinces of the empire with each other and the home kingdom. Every province of the empire promptly came to the assistance of the mother country even before its assistance was sought. Instead of setting up a rebellion the princes of India sent their troops and supplies to battle fields of France. The Boers of South Africa—but lately at war with England—promptly took up arms against the German colonies. Canada and Australia rendered wonderful help. Even the Maoris of New Zealand contributed their share. The inevitable result of united effort was to awaken a consciousness of unity, a recognition that they formed one united people.

INCREASE IN DEMOCRACY.

The ordeal of war led to a wonderful increase in the spirit of true democracy. It could not be otherwise for rich and poor, high and low, stood side by side in the trenches while the entire nation—all classes and ranks—voluntarily made great sacrifices for the common good. Neither Magna Carta nor the old revolution effected such profound changes in English thought. It showed itself in many ways. The recognition of the great work of the women of England during the war, in shops and factories, in offices and on the farm, in explosive and munition factories, in doing the work of tens of thousands of men just behind the firing lines, the rights of suffrage were extended to them. They soon demonstrated that they both knew how, and proposed to use the franchise to advance the cause of democracy.

Old conditions in England will never return. We have already seen that the ancient House of Lords which long preceded the House of Commons in English history, had lost its veto power. Still more far-reaching changes are in sight. It will doubtless soon lose its hereditary character, and become instead an elected body, when it will be analogous to our Senate. Furthermore, the United Kingdom will—it is thought—become the United States of England, Ireland, Scotland and Wales.

SOME NATIVE PEOPLE OVER WHICH GREAT BRITAIN RULES.

THE UNITED KINGDOM

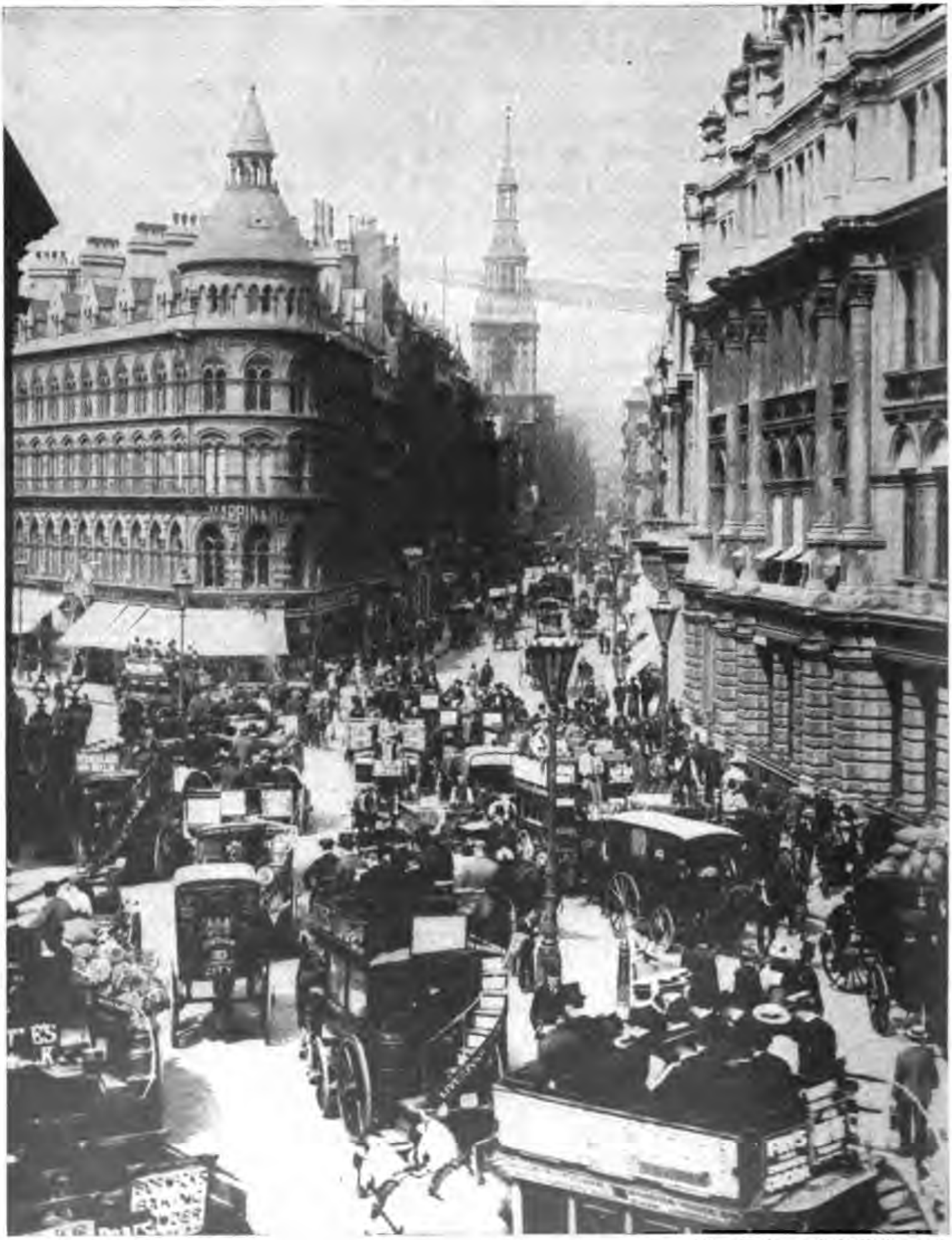
COMMERCE.

This consists of England, Wales, Scotland, Ireland, the Isle of Man and the Channel Islands. The united area of these component parts is 121,386 square miles, or an area just about as large as our state of New Mexico. In England is located the largest city of the world, London, having in its last census year a population of 7,252,396. This city is not only the capital of the United Kingdom and the center of the British Empire, but it has long been the financial and business capital of the world. England has constituted herself a sort of business clearing house for the world and merchandise from the United States, from South America and other sections of the world is imported into England and thence distributed to other sections of the world. Hence it is that in 1912 the total imports into the United Kingdom reached the enormous sum of $3,625,038,883, and the exports from that country were $2,095,465,313. The total of these figures is far in the lead of those of any other country.

SHIPPING.

To handle this commerce requires the service of a very large number of ships, and the United Kingdom not only has by far the largest navy in the world, but her merchant marine is far in the lead of that of any other country. In the last census year the number of vessels of both classes, sailing vessels and steamers, belonging to that country was 21,072. For the British Empire as a whole these figures would be nearly double. Thus it comes about that the English flag is by far the most frequent one seen, and on every sea. There is not a port in the world where it is not a frequent visitor. From this we see the importance of her numerous coaling stations scattered all over the world, with supplies of coal for her navy and for passing steamers. The ship-building industry is of enormous proportions. In the last census year 1,398 vessels were turned out by her shipyards; however, 322 of that number were built for other countries. The banks of the River Clyde in Scotland are lined with ship yards, and there the larger part

THE ENGLISH ROYAL TRAIN.



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VIEW IN LONDON—CHEAPSIDE.

of this shipping is built. For her inland trade there are about 23,000 miles of railroad.

MINING.

All of the principal metals are mined in some part of the United Kingdom, even gold and silver are not unknown. Not many years ago that country led in the production of iron and coal, but the United States is now far in the lead. Yet in 1913 the United Kingdom produced about 320,000,000 (short) tons of coal, and in the last census year nearly 16,000,000 tons of iron ore. While the amount of coal remaining in her mines, according to the estimate of the Geological Survey, is many billion tons, yet the cost of mining is so rapidly increasing that the country is really somewhat concerned over the situation. We might remark that the tin mines of Wales have been known from the very earliest times. The ancient Phœnicians obtained their supplies of tin from that source, and they were extensively worked when Great Britain was a part of the Roman Empire.

AGRICULTURE AND MANUFACTURING.

About one-fourth of the total area of the United Kingdom, or 19,687,000 acres, is classed as arable, the greatest proportion of arable land being in England; very little in Wales. More than a third of the area is classified as "permanent pasturage;" nearly half of Ireland is thus described. About one-sixth the total area is put down as "mountain and heath grazing land." Nearly half of Scotland is of that nature. The great industry in the United Kingdom is manufacturing, and the textile industry is the principal one. More than one-half the exports consist of textiles. The total amount of capital interested is about a billion and a half of dollars. About 5,000,000 people, in all, depend upon that industry for their livelihood. In Lancashire, England, in 1912 there were nearly a million looms and nearly sixty million spindles employed. To supply those mills, Great Britain imported the last census year 1,972,864,320 pounds of cotton, the far larger portion from the United States, and 2,425,000 bales of wool, very largely from Australia.

CANADA

Canada is the largest single member of the British Empire, with an area of 3,729,665 square miles. It is considerably larger than the United States and Alaska, and almost as large as the United States and all of its non-contiguous territory. It includes all that part of the continent of North America north of the United States, except Alaska, Newfoundland and Labrador. In the last census the population was reported as 7,204,838. But the period of development for Canada is just beginning, and undoubtedly each decade for the next 50 years will see a very rapid growth in population. The mere fact that within the last decade 750,000 people have emigrated from the United States to Canada shows that the vast natural resources of that country are beginning to attract attention.

THE DOMINION OF CANADA.

The official name of this possession is the Dominion of Canada. It is a union of nine provinces, having under their political control two immense territories. On reflection, this is seen to be the same method as that pursued in our own history, for we also have the union of independent states, and under our control are other sections not admitted to statehood. These two Canadian territories are Yukon and the Northwest Territory. They comprise all that part of the dominion north of the sixtieth parallel and west of Hudson's Bay. Their combined area is 2,129,811 square miles. From their location in the extreme north of the continent it will be a very remote time, if ever, before they will be possessed of a population sufficient to justify their being given the privileges of a province. The nine fully organized provinces of Canada will undoubtedly be populous states in the not distant future.

The largest of their provinces, Quebec and British Columbia, each exceed 350,000 square miles in area. That is an area equal to all that part of the United States north of the Ohio, east of the Mississippi and west of the Hudson rivers. It will be seen that each is an empire in itself. However, a large part of Quebec, between the ocean and Hudson's Bay, will probably never be a populous section. Three of these provinces, Ontario, Alberta and Saskatchewan, exceed 250,000 square miles each; that is about the size of Texas, the largest state in the Union. Manitoba has 73,732 square miles, which is an area larger than New England. New Brunswick is 27,985, and Nova Scotia 21,428, a combined area nearly as large as Alabama. Prince Edward's Island is the smallest of the provinces, some more than twice as large as Rhode Island.

GOVERNMENT.

Being a constituent part of the British Empire, the crown appoints the governor-general. The legislative body is composed of two houses. The Senate consists at present of 87 members, distributed as follows: 24 each from Ontario and Quebec, 10 each from Nova Scotia and New Brunswick, 4 each from Manitoba, Prince Edward's Island, Alberta and Saskatchewan, and three from British Columbia. The members of the Senate are appointed for life by the crown, on the nomination of the ministry for the time being. Each nominee must be 30 years old, a resident in the province for which he is appointed, a natural-born or naturalized subject of the king, and the owner of property amounting to $4,000.

THE HOUSE OF COMMONS.

This body is also composed of natural-born or naturalized subjects of the king. No property qualification is required, and its members are elected upon a very wide suffrage. For electoral purposes, each province is divided into districts, each of which returns a member on a vote taken by ballot. The members of the House elect their speaker, and twenty, including the speaker, form a quorum.

PROVINCIAL GOVERNMENTS.

Each province has also a separate legislature and administration, with a lieutenant-governor, appointed by the governor-general. Only two of the provinces, however, have two legislative chambers. These two are Quebec and Nova Scotia. The others have but one legislative assembly. Like our states, each province is independent in local affairs.

THE JUDICIARY.

Justice in Canada is administered by judges, police magistrates and justices of the peace, of whom the first named are appointed for life by the governor-general, from among the foremost men at the bar of the several provinces.

THE SUPREME AND EXCHEQUER COURTS.

The Supreme Court of Canada is composed of a chief justice and five puisne judges, and holds three sessions annually, at Ottawa. The only other dominion court, namely the Exchequer Court of Canada—is provided over by a separate judge, and its sittings may be held anywhere in Canada.

THE PROVINCIAL COURTS.

The provincial courts include the Court of Chancery, Court of King's Bench, Court of Error and Appeals, Superior Courts, County Courts, General Sessions and Division Courts.

RESOURCES OF CANADA.

The prevailing industry in Canada is agriculture; but dairying is becoming more and more important, and fruit raising in some sections is rapidly increasing. Especially is this true in Nova Scotia and in the western provinces. In the last census year 1,604,477 barrels of apples were exported. All the prairie provinces are great wheat producing sections. It is estimated by government experts that if only one-fourth of the land suitable for wheat raising in the three prairie provinces of Alberta, Saskatchewan and Manitoba were used they would harvest over 800,000,000 bushels of wheat yearly. In 1912 the area under cultivation for all crops was 32,449,000 acres, and the value of the crops was $511,951,000, but the amount of land cultivated is only a small fraction of the total arable land in the dominion.

The fact is, the resources of Canada are almost untouched. There are immense deposits of iron ore and other valuable metals waiting development, but even at present more than $100,000,000 worth of metals are produced yearly. The manufacturing industry is also gaining. The last census shows an output valued at $718,352,603. There is an immense amount of water-power in the eastern provinces that can be developed. Already at Niagara Falls and the Soo immense power plants are being erected. The timber industry is very great. The timber reserves are estimated at nearly 850,000 square miles, an area as large as all east of the Mississippi River in the United States. But the lumbermen are at work. In the last census year more than 2,000 sawmills and a large number of pulp mills, assisted by an army of over 50,000 workmen, were turning out products valued at about $70,000,000. But the forest area is so vast that the timber resources are practically inexhaustible. The foreign trade movement in the last census year was: Imports, $492,362,989; exports, $301,316,045. As might have been expected, the United States was by far the best customer Canada possessed.

TRANSPORTATION ROUTES.

Canada fronts on both oceans, the same as does the United States. She enjoys with us the same immense extent of inland navigation furnished by the Great Lakes. She has spent nearly $100,000,000 in building up her canal system and has most ambitious schemes for further enlargement under consideration, and in the last census year 35,955 vessels utilized those canals. Three great lines of railways traverse the dominion from ocean to ocean, and they are so crowded that they are double tracking these routes and spending enormous sums on improvements. The total railroad mileage is over

25,000 miles. Her Atlantic ports, Quebec, Montreal and Halifax, are connected with Europe by fast steamship lines. Her great western port is Vancouver, and from thence regular lines of steamers connect with Australia, Japan and China. A new port, Port Arthur, on the Pacific shore, is being opened up.

THE CANADIAN LUMBER INDUSTRY

In early times the forests of Canada extended in an almost unbroken stretch from the Atlantic ocean to the head of Lake Superior, a distance of 2,000 miles.

LUMBERING NEXT TO AGRICULTURE.

Next to agricultural pursuits, in which 56 per cent of the population are engaged, lumber is the most important industry of the Dominion. The capital invested in it represents $100,000,000, the annual output amounts to $100,000,000, and the annual wage list is more than $30,000,000.

A "WOODEN COUNTRY."

The reputation of Canada as a "wooden country" rests primarily on the fame of its white pine in the province of Ontario.

THE TIMBER OF QUEBEC.

The chief lumber riches in the province of Quebec consist of spruce, with some pine and birch timber, and cover an area of 48,000 square miles.

NEW BRUNSWICK'S TIMBER LAND.

In New Brunswick the area of timber land under license is 6,000 miles.

FORESTS OF BRITISH COLUMBIA.

To British Columbia, however, belong the trees most admired in the lumber trade and out of it. Its red cedar is one of the most valuable of timbers. Its forest area is 285,000 square miles, or 182,400,000 acres, and it is really the timber province of Canada.

LOGGING IN CANADA.

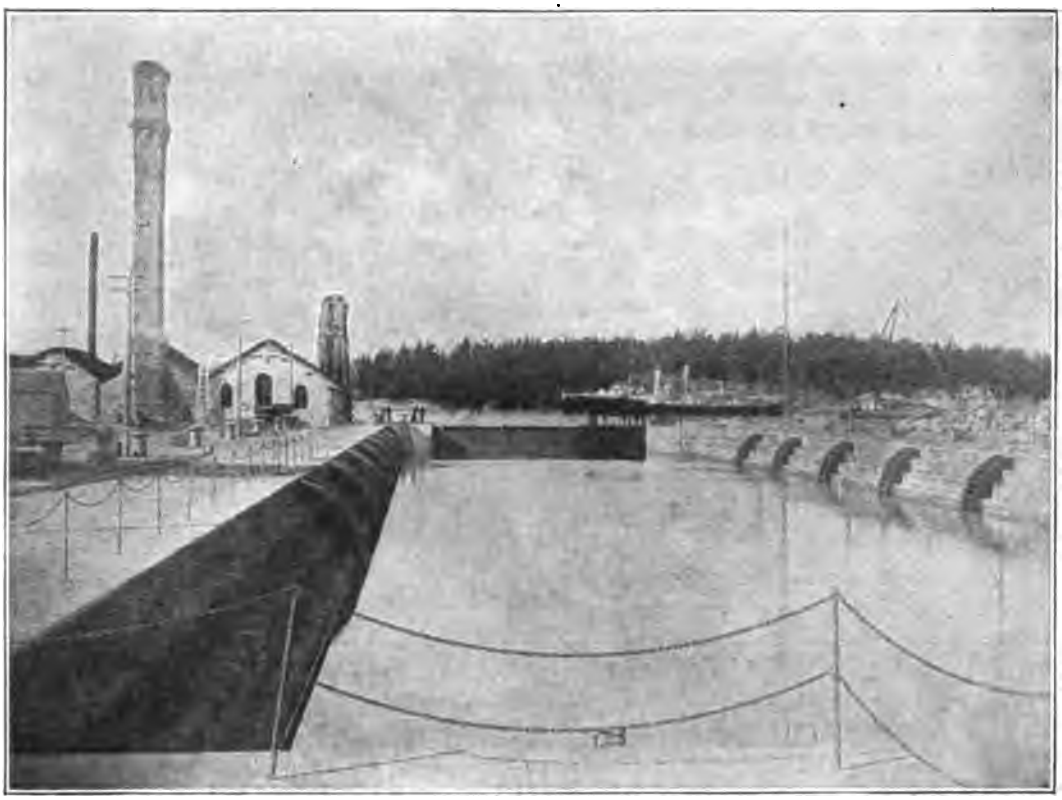
THE GIGANTIC DOUGLAS FIR TREE.

Along the coast of British Columbia is grown its most valuable wood—the Douglas fir—which has no competitor in length, strength and straightness. Some of the trees grow to a height of more than 300 feet, and have a circumference of over 50 feet, thus approximating the size of the colossal redwoods of California. The Douglas fir is likely to prove a valuable paper making tree.

British Columbia also contains species of spruce, hemlock, cottonwood, balsam, white pine and red cedar. The last named is, for general purposes, the most valuable wood on the Pacific coast, where all these varieties are to be found.

FLUMES SHOOTING LOGS FROM MOUNTAIN TOPS.

In British Columbia flumes are used to float logs from mountain tops to sawmills. The loggers nail boards together and come down the same way, traveling sometimes a mile a minute.



BRITISH NAVAL DRY DOCK AT ESQUIMALT. BRITISH COLUMBIA
Showing Water at Normal Level Before Receiving Ship for Repairs.

SAWMILLS.

In this province are 60 great sawmills, with a daily capacity of more than 3,000,000 feet of lumber. The yearly cut of British Columbia is 75,000,000 feet.

In the depth of winter the mill owners, who lease the timber land from the government, send out large gangs of laborers to fell the huge pine and other trees, previously marked by "explorers," preparatory to making them into square timber or saw logs.

FIVE KINDS OF HANDS.

Five kinds of hands are necessary for the woods—the foreman, the hewer, the liner, the scorer and the road-cutter. To these should possibly be added another, the cook.

HANDLING SAW LOGS.

If saw logs are being cut, they are hauled over cliffs and down ravines to the banks of the various tributaries of the principal rivers, where, before the thaw sets in, millions of cubic feet of timber are collected.

MONSTER RAFTS.

When the ice-bound streams are free in the spring, the logs, loosely joined together in rough rafts, are set adrift in the rivers, some of the rafts in New Brunswick covering a space of ten acres.

The method of camping, cutting the trees, getting them to the mills and working them up into the various forms of marketable lumber is substantially the same as that pursued in the timber regions of the United States, and described in the article entitled "Logging in the Northwest."

THE CANADIAN MAPLE.

The maple (Acer), whose leaf is the emblem of Canada, is a lofty tree, with particularly luxuriant foliage. The wood is very close-grained and hard, highly ornamental, and is esteemed for the beauty of its fibre. When polished it possesses a silky lustre. It is used for heavy furniture, cabinet work, and for railway carriages, where strength is required.

AGRICULTURE IN CANADA

THE SOIL IN UPPER CANADA.

In the vast plateau stretching westward through Upper Canada, on both sides of Lake Erie, farming is a comparatively easy vocation. The yield of wheat is abundant in the southern portion, but north of the wheat limit the land is poor and rocky.

In the wheat region, cattle and dairy products also constitute large items in the farmer's receipts.

THE GENERAL PRACTICE.

It is the general practice to allow the land to remain for two years in artificial grasses and clover, to break it up in June, and sow wheat in autumn. The only formidable foes encountered by the Canadian farmer in raising wheat are rust and mildew, which early sowing largely prevents. When these are absent, the comparatively high temperature of the autumn pushes forward the wheat plants, and produces a thick carpet of vegetation.

INDIAN CORN.

On the inferior lands some fine crops of Indian corn are grown, being planted in May and maturing about the middle of September.

LOWER CANADA.

Much of the soil in Lower Canada is a dark-colored sandy loam. Timothy grass grows well on it, but the clovers only last one year. Oats, barley and potatoes are the staple crops in the island of Montreal and other parts.

ALONG THE ST. LAWRENCE.

There is a variable breadth of alluvial soil along the banks of the St. Lawrence River, but for some miles west of Quebec little arable land is observable. The area of first-class farming land in Canada east is not extensive.

THE SWAMP LANDS.

The deposits of swamp muck found more or less in all parts of Canada, result from gradual accumulation of partially decomposed vegetable matter—the remains of successive generations of plants, chiefly aquatic. These deposits furnish the farmer a liberal supply of plant food for his crops. If dug in autumn, thoroughly aired, exposed to the winter's frosts and then mixed with lime or marl and wood ashes, the compost is much valued as a fertilizer by the Canadian farmer. Marl, which is essentially carbonate of lime, is chiefly found in connection with the muck beds, and when readily obtained is the cheapest article which the farmer could use for the purpose.

CANADA'S WHEAT CROP.

The production of wheat in Canada for the year 1902 was 87,555,891 bushels. This amount gives the Dominion the ninth place in a list of 22 of the great wheat-producing countries of the world, the combined crop of which, in 1902, was 2,820,333,614 bushels.

PERCENTAGE OF FARMERS TO POPULATION.

The Canadian census of 1890 showed that the number of persons engaged in agricultural pursuits in the Dominion of Canada—farmers and farmers' sons—was then 649,506. These and their families then made up 45 per cent of the entire population of the country.

NEW APPLICATION OF THE GRAIN PRODUCT.

The very low prices which prevailed for wheat and the coarse grains for some years after the taking of the 1890 census, led a large number of farmers to turn their attention to more profitable methods of disposing of these crops than by their bluk sale in the markets.

EXPERIMENTAL FARMS.

About that time a central experimental farm, with several branches, was established by the Dominion parliament for the purpose of making agricultural tests whose results would enable the farmers to derive more profit from their labors.

The experiments conducted at the government farms demonstrated the fact that wheat, as well as other grains, might be made a greater source of profit by converting them into beef and pork than by selling them in their crude state, and this course was pursued on numerous farms with pronounced success.

THE DAIRY PRODUCT.

The investigations made under government supervision also showed that the feeding of these grains, mixed with suitable succulent food, such as ensilage, to cows and converting their milk into cheese and butter was more profitable than selling the grain. In consequence of this, the dairying industry grew very rapidly, and the demand for first-class dairy products became almost unlimited.

CANADA'S LONG BRIDGE SPAN

The bridge recently completed across the St. Lawrence river, six and a half miles south of Quebec, has the longest span in the world.

THE GREAT ST. LAWRENCE.

The great St. Lawrence flows between high, rocky cliffs at that point, and varies according to the tide. The water is about 180 feet deep in the channel, and flows by at a swift rate. The channel is crossed with a suspended span and two cantilever arms, making the unsupported structure 1,800 feet long, which by far is the longest span in the world. It is 200 feet longer than the span of the new East River bridge, New York. The length of anchor arms on each side of the main spans is 500 feet, with one approach span of 220 feet at each end, between anchor piers and terminal abutments.

The length of the structure, including abutments, is 3,300 feet. The substructure consists of two main piers, two anchor piers and two abutments. One of these anchor piers is founded on solid rock, and the other on hard blue clay. The sinking of the main caisson was a great engineering feat. At low tide the water is only ten feet deep around the two main piers.

SINKING OF THE CAISSON.

The caisson was sunk through a compact mass of granite bowlders, bound together with cobble stone and fine gravel. The penetration of the caisson was so slow that on some days the distance could not be recorded; on other days it was scarcely more than four inches, although it bore a load on its roof of more than 20,000 tons.

Owing to the immensity of this load, and its attendant danger, this method was finally abandoned, and concreting in the working chamber was begun. Progress by this method was rapid, and in 17 days the pier was built. The caissons for the two main piers are each 150 feet long, 49 feet wide and 25 feet high. They are of southern pine. The caisson for the north pier was built on the north shore, about 4,000 feet east of the pier site; it was successfully launched, towed into position, and made fast in a berth previously prepared in the short space of 70 minutes.

SHOOTING LACHINE RAPIDS, ST. LAWRENCE RIVER.

THE FUTURE.

Canada is in the heyday of prosperous youth, with a brilliant future opening before her. The ocean waters off her shores teem with valuable fish, her forest reserves are on a magnificent scale; from her prairie provinces—each of vast extent—she can feed the world. She has vast mineral wealth as yet untouched, practically inexhaustible water-power to be developed. She awaits the great population that will surely be attracted to her in the near future with outstretched hands, knowing that she has room for all the immigrants, and in the enjoyment of her free institutions they will build up an enduring nation, the largest, possibly the richest and most populous, of the many constituent parts of the British Empire.

AUSTRALASIA

The British possessions in the southern seas known officially as Australasia, include the continental island of Australia, New Zealand, Fiji and Papua. The total area of this part of the British Empire is 3,192,677 square miles, thus a little larger than the United States proper; the total population, however, is less than six million. Australia is by far the most important member.

MELBOURNE, AUSTRALIA.

AUSTRALIA.

Australia possesses an area of 2,974,581 square miles. It is situated in the South Tropical and South Temperate zones, hence its seasons follow in reverse order those of the United States. In general terms, longitude 135 east passes through the center of the island, and thus it is south of the Philippines at a distance of about 1,500 miles from Manila, or we may say it is situated 6,000 miles southwest of California. Australia, for administration purposes, is divided into six states. The crown appoints the governor-general, but the legislative body is elected by the people. The machinery of government is not widely different from that of the United States. They have a Senate, a House of Representatives and a Supreme Court. The last census gave the commonwealth a population of 4,568,707. The capital is Sydney, on the eastern coast, a city of over 600,000 inhabitants. Melbourne, in the southeast, has about the same number. The population of the island is steadily increasing. From forty to fifty thousand immigrants have been going from Great Britain to Australia yearly.

INDUSTRIES.

The large area of Australia will be noticed, but a very large part of that area is a desert expanse, though large irrigation projects are under way, and it may be the desert will recede before the advance of intelligent husbandry as it has in our own arid sections. In the last census only 12,106,642 acres were under cultivation. The principal crop is wheat, of which 71,930,000 bushels were produced. The development of the fruit industry has been very rapid, but sheep raising is almost the principal industry; in the last census 91,667,881 sheep were reported. Frozen mutton from Australia has been laid down in San Francisco at a profit, and immense supplies are shipped to England.

THE WOOL INDUSTRY IN AUSTRALIA.

The 28,000 square miles of volcanic country in the western portion of Victoria, Australia, with its sweet and strong kangaroo grass, is considered the best sheep-growing region in the British colonies.

The sheep in that section look after themselves all the year round. In very dry seasons, however, a little hay is given to the young sheep when they are teething and cannot cut the dry grass.

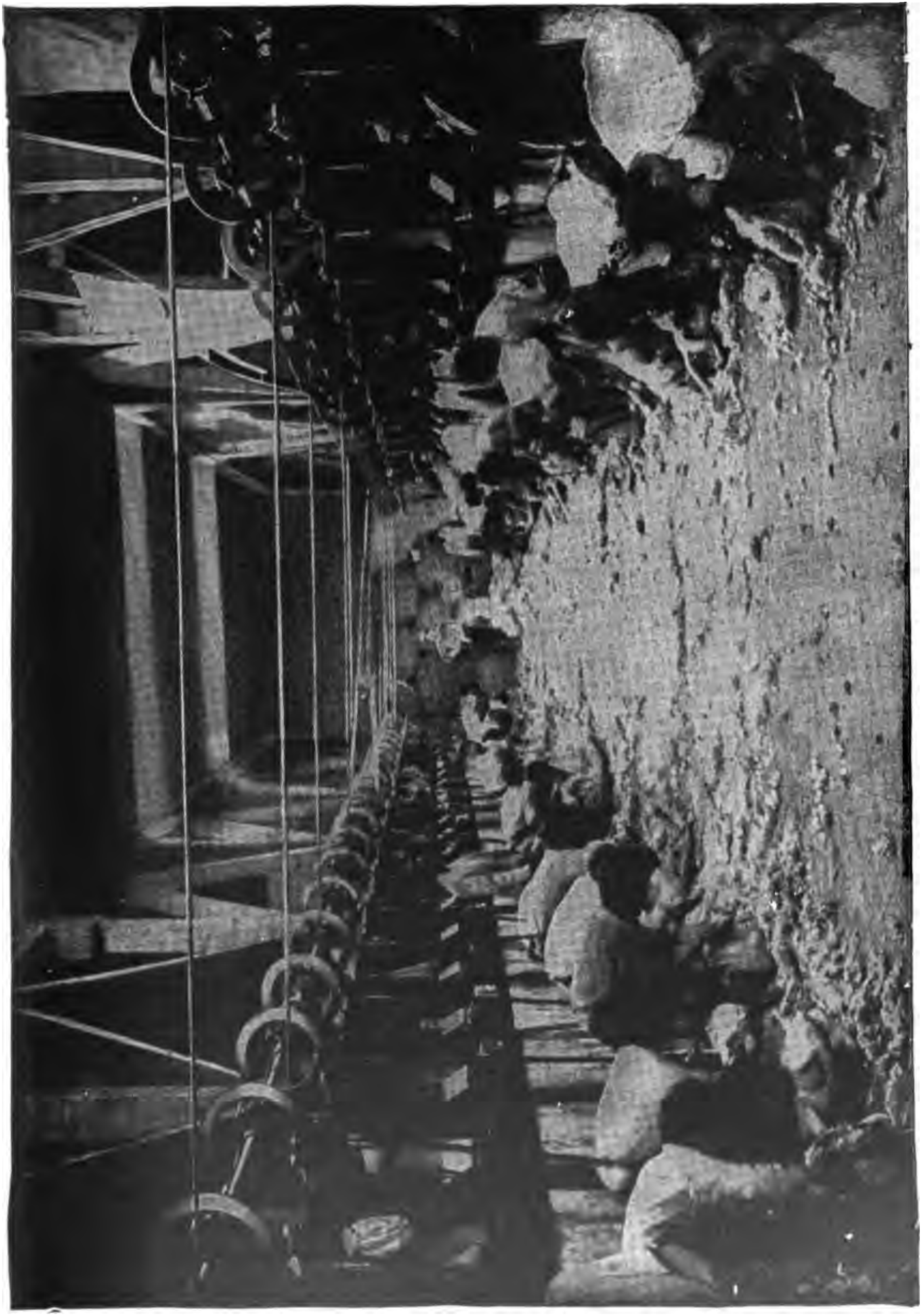
The Victorian sheep stations are fenced with smooth wire, except in the volcanic country, where stone walls are used. The paddocks average about 800 acres in extent, although some are large enough to support 2,000 sheep. Some of the stations include 20,000 ewes, lambs and wethers, which are kept in separate flocks.

AUSTRALIAN WOOL TEAM.

SHEARING BY MACHINERY.

Where shearing is done by hand, one shearer is employed for each 2,000 sheep, and if an expert, he will average 80 head per day.

In 1891, however, machinery was introduced for this purpose, and in the first two

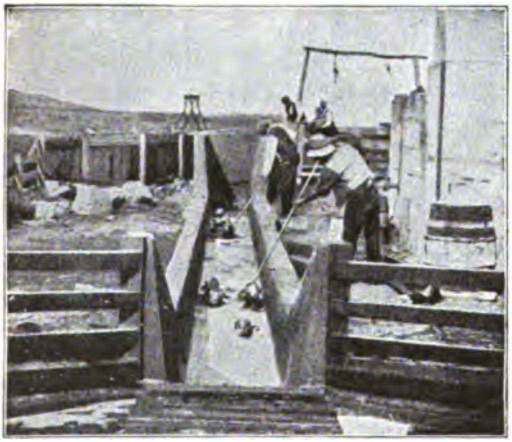


AUSTRALIA—SHEARING SHEEP BY MACHINERY.

years of its use 50,000,000 sheep were thus shorn. After shearing, the fleece is sorted, combed, bound, pressed and baled—the bales being 2 feet 6 inches by 4 feet, and weighing about 400 pounds.

THE CANNIBAL TREE OF AUSTRALIA.

One of the most wonderful forest trees in the world is the "cannibal tree" of Australia, which grows in the shape of a huge pineapple, and seldom attains a height of more than 11 feet. It has a series of broad, board-like leaves, growing in a fringe at the apex, which remind one of a gigantic Central America agave.



SHEEP CLEANING IN NEW ZEALAND.

When standing erect, these broad, thick leaves hide a curious-looking arrangement, which appears to perform the same functions as those of the pistils in flowers. Naturally, these board-like leaves, which are from 10 to 12 feet long in the smaller specimens and from 15 to 20 in the larger, hang to the ground and are strong enough to bear a man's weight.

WORSHIPPED AS THE "DEVIL TREE."

In aboriginal times the natives worshipped the cannibal tree under the name of Devil tree, the chief part of the ceremony consisting of driving one of their number up the leaves of the tree to the apex. The instant the victim touched the so-called pistils of the monster, the leaves instantly flew together like a trap, squeezing the life out of the intruder. Early travelers declare that the tree held its victim until every particle of flesh disappeared.

A CUSTOM PECULIAR TO NEW ZEALAND.

Sheep are cleansed by law in New Zealand. In order to rid them of vermin, a matter likely to be neglected, parliament passed an act making a soaking process necessary. In accordance with this, long waterways are constructed and the animals are compelled to swim the full length of one of these courses, while men with poles push their heads under water as they pass. This immersion drowns the vermin and thoroughly renovates the wool, besides being a very wholesome and agreeable process for the sheep to undergo.

MINING AND MANUFACTURES.

In the mountain ranges which traverse the eastern part of Australia are many rich mining sections, and all sorts of valuable minerals are produced. Though the discovery of gold in 1851 led to the first extensive settlements and for years that was the principal gold-producing country in the world, yet as a whole only a beginning has been made in the mining industry. As it is, over a hundred million dollars' worth of metals are produced yearly. Very nearly 160,000 square miles of forest area are set aside by the state for forestry purposes. Manufacturing is having a rapid development. The value of the output the last census was $603,853,270. Among the principal items of production are lumber, dairy products and flour.

AUSTRALIA IN EARLY AGES.

The naturalist finds much of interest in the fauna, flora and primitive inhabitants of Australia. Many believe that the island is only a fragment of a very ancient continent which once stretched far to the west and east of the present island and that the strange animals and plants found are survivals of species which long since died out in other parts of the world, and some believe that in the primitive tribes are members of primitive races long preceding the dominant races of to-day.

INDIA

AREA.

India is one of the most important possessions of the British Empire. It is certainly one of the oldest settled sections of the world. Thousands of years before Great Britain was known to the outside world, India was the seat of a relatively high civilization. The area is given as 1,773,088 square miles, as large as all of the United States east of a line drawn due south of the eastern boundary of Montana, but not cutting off the Panhandle of Texas. On the whole, it is a fertile section of country. The southern end of the peninsula is within the tropics, but it is an elevated plateau section and the climate is better than much of the great central plain. India is traversed by three immense rivers, the Bramahputra on the east, the Ganges, also in the east, and the Indus in the west. And there are innumerable tributaries. These great rivers are fed from the Himalaya Mountains separat-

ELEPHANTS IN INDIA TRAINED TO WORK.

ing India from Asia on the north, but the rainfall over a large part of the central sections is uncertain and often deficient, and terrible famines occur. Deficient rainfall is being partially met by irrigation. The irrigating canals constructed by the government furnish water for about 18,000,000 acres, and as many more are irrigated from wells and reservoirs.

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STREET SCENE IN CALCUTTA—SNAKE CHARMERS.

POPULATION.

The population reaches the enormous total of 315,486,372. Thus on less than two-thirds the area of the United States is a population three and a third times as great. Of that population, less than half a million can speak the English language. The great majority of the people are poverty-stricken and ignorant, swayed by tribal customs from which the people of Europe emerged thousands of years ago. The great mass of them have only vague ideas about the world at large, though the educated, ruling classes are fully informed in all respects. More than sixty-five million of them are Mohammedan in belief and thus it is that Great Britain contains in her vast possessions more than twice as many Mohammedans as those who owe allegiance to the Sultan of Turkey. This is one of the facts that explains why the appeal of the latter sovereign fails to incite the Mohammedans of the world to a Holy War in defense of his throne.

Another interesting fact discloses itself in reference to this population. In the last census 217,586,920 were reported as professing Hinduism. This is the only body of people now professing the religion of the primitive Aryan race which reached its greatest height as a philosophical system many centuries before Christianity started on its conquering career. Modern Hinduism, however, is for the vast mass of its followers nothing but abject Paganism, some of the worst features of which have been abolished by the British government. To complete these statistics, we might add that Buddhism was professed by 10,721,449, and at the time of the last census there were 3,876,196 professed Christians. In proportion to the population these figures are small, but it is doubtless the leaven, hid at present in this numerous population, that is destined in time to leaven the entire mass.

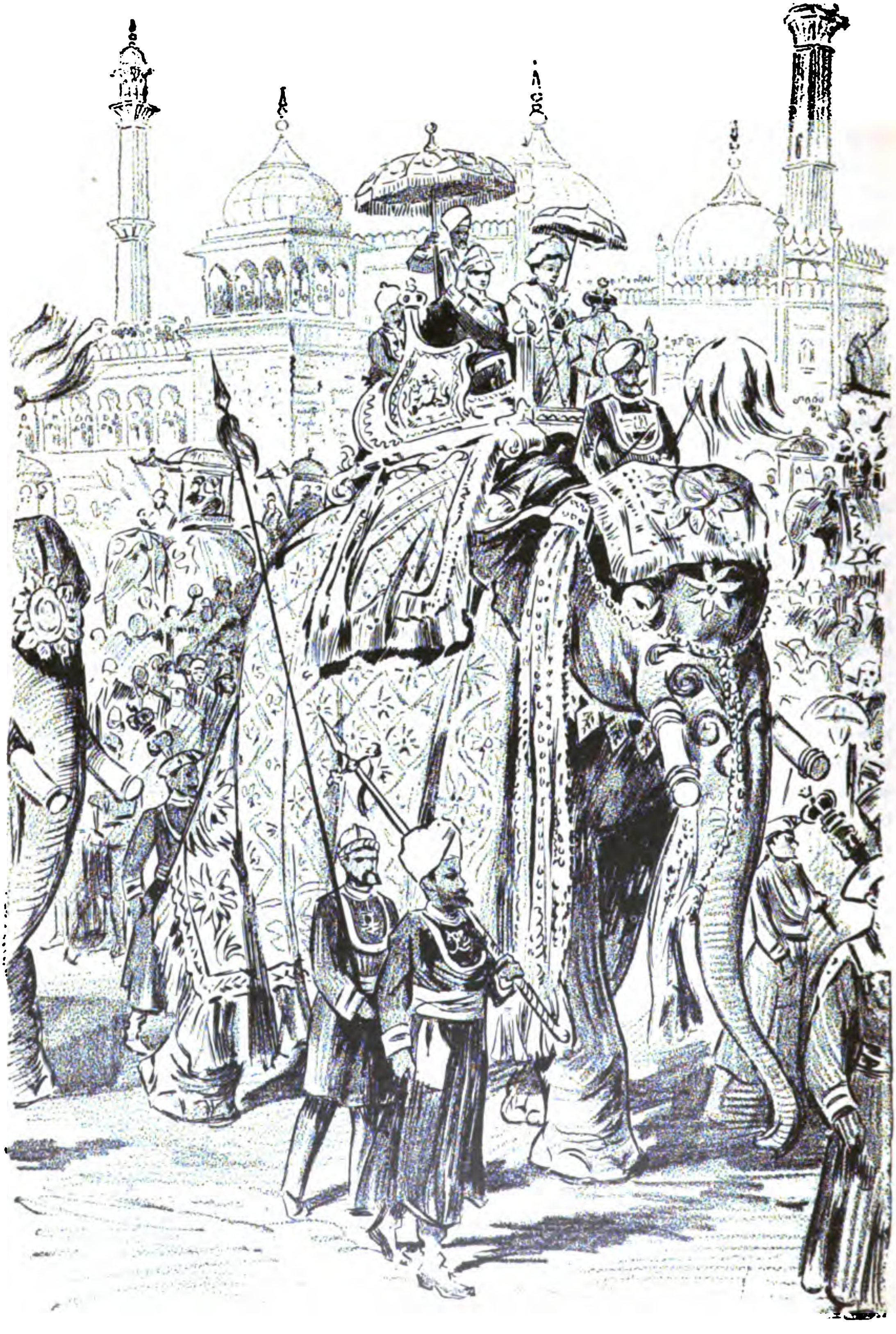
GOVERNMENT.

For the purpose of administration, this vast territory is divided into ten large and five small provinces. The viceroy and governor-general is appointed by the crown. Three of the large provinces, Madras, Bombay and Bengal, have at their head a lieutenant-governor appointed by the governor-general. Large parts of India—as Rajputana—are nominally under the government of native princes—but these princes rule only according to good pleasure of the British officials. They are not allowed to make war nor peace, nor to send ambassadors to each other, or to external states. The king of England is also emperor of India, hence it is that in the great European War, the strange spectacle was seen of troops from India fighting in the ranks. of the allies in Europe.

THE NATIVE RULERS.

It must not be forgotten that these native princes are Orientals, and the Oriental mind delights in pomp and ceremony. The accession of a new sovereign in England means also the accession of a new emperor in India, and then it is that the subject princes assemble in the ancient capital—Delhi—the city that centuries ago was the oriental capital of the Mohammedan conquerors of India, where yet remain magnificent palaces eloquent of vanished greatness. But now the assembled princes come to do homage to the king himself, their emperor, if he be present, as was the case with the present emperor—if not to his representative—the viceroy.

At such times the splendors of long ago are revived. It is the same scene as those that attended the swearing of fealty to the Mongol Conquerors in the days of Gengis Khan. Long lines of elephants pass in procession, each carrying a gold or silver howdah, and is also adorned with costly cloth of the same material; the princes riding in the howdah are dressed in wonderful robes, blazing with gold and gems and



embroideries almost more costly still. Such a scene can be witnessed nowhere but in India.

THE TAJ MAHAL.

At Agra, near Delhi, is located the Taj Mahal, said to be the most beautiful tomb in the world. It was erected by Shah Jehan early in the seventeenth century in memory of his beloved wife. The crypt is of white marble, 185 feet square, situated in the center of a court 315 feet square. Each corner of this large court is adorned with a beautiful minaret. Over the center structure is an exquisite white marble dome, 58 feet in diameter, 80 feet high, resting on four corner chapels, each crowned with a dome. The interior decorations consist of beautiful stones in arabesque patterns, mosaic and inlaid work of unsurpassed beauty.

AGRICULTURE.

Agriculture is the leading industry. There is about 600,000 square miles of cultivatable land, about 350,000 square miles were under cultivation in the last census year. Evidently all the food India raises is needed for home consumption, but food products form the principal item of export, nearly $200,000,000 being exported in the last census year. Nearly 130,000 square miles of her area is in forests. Manufacturing is making some headway, especially in the textile industry, cotton, jute and woolen fabrics, and some sugar mills. The export of manufactured articles in the last census year was $123,362,299. All minerals are mined in India, and nearly 150,000 persons were reported as being employed in that industry. The total foreign trade movement in India amounts to considerably more than one billion dollars yearly.

PLOWING IN INDIA.

CINNAMON TREE IN CEYLON.

CINNAMON.

One of the most valued products of India, grown in the island of Ceylon, at the southern extremity of the peninsula, is cinnamon.

The plant or tree is raised most readily from seeds, although the finer kinds are propagated by layers. The wood of the tree is light. The branches are thick and spreading, and shoot forth horizontally or inclining downwards, with numerous oblong leaves growing in pairs opposite to each other. The cinnamon berry is small and has the form of an olive, with a kernel.

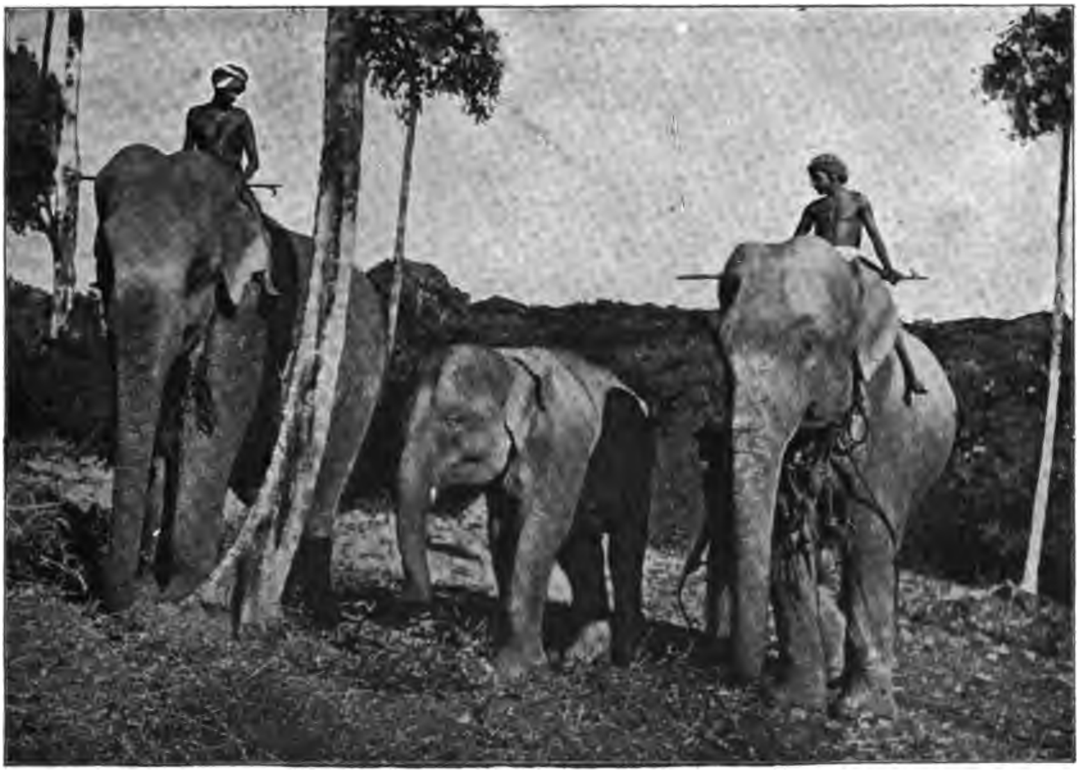
It adheres to a thick green and hexangular receptacle in the manner of an acorn. The peeling process commences early in May and continues until late in October. Two longitudinal slits are made in the bark, which is gradually loosened with the convex side of a knife, and then half of its circumference usually comes off in one entire slip. The epidermis, together with the greenish pulpy matter immediately under it, is carefully scraped off. When sufficiently dry, it is made up into bundles weighing about 30 pounds each. Ceylon alone has 37,000 acres of land devoted to the cultivation of cinnamon. It is grown to some extent in China, and several species of the plant in a wild state are found in Java.

THE FAUNA.

The fauna of India affords illustrations of extremely interesting and useful animals, also those ferocious and dangerous, and venomous serpents. The elephants of India are regarded as the most intelligent and useful of their species. They are still to be found in their wild state, but their capture is not difficult, and they are easily trained and made to perform all manner of useful work. Tigers are a great curse in the jungle sections of India; whole communities fre-

COCOANUT TREE CLIMBER IN CEYLON.

quently live in terror from their attacks. At such times, the services of renowned hunters are in demand, and the killing of the animals is the occasion of great rejoicing. Poisonous serpents, especially the cobra, are literally a scourge to the country. Many thousand people die every year from their bite.



ELEPHANT HUNTING OR KRAALLING IN CEYLON.

The two tame ones are helping to capture the wild one between them. If he attempts to escape, they throw their trunks around him and hold him fast.

CITIES OF INDIA.

Calcutta in Bengal is the most important city, with a population of 1,216,000. It was formerly the capital, but in 1912 Delhi was made the capital. This last city is small, compared to Calcutta, but it was the ancient captial and is of great historic interest. Bombay, on the west coast, is important commercially, as it is the home of the Parsees who fled from Persia to India centuries ago. It is interesting to know these Parsees are fire worshippers, the only remnants of the once powerful religion of Mazdeism in Persia. They have now become a very wealthy and influential factor in Bombay. There are two other cities of 500,000 population, six of over 200,000, about thirty over 100,000, and fifty others of over 50,000 each.

THE FUTURE.

The future prosperity of India is in the hands of people of India. It is absolutely essential to future advance, that the inertia of ages be overcome, and the people awake to modern life and culture, that habits of thought, customs of life—such as notions of caste—and pagan beliefs—give way to modern education and the customs, beliefs and practices of civilized lands. If that can be accomplished—and great progress is being made in all these directions—there is no reason why India should not become one of the most prosperous component parts of the British Empire.

BRITISH AFRICAN POSSESSIONS.

Within recent decades the countries of Europe have roused to the fact that Africa is a continent of possibilities. It is true that a large part of it is a desert, that other large portions are now tropical jungles, and that the population is largely composed of tribes still very backward in development. But time will change these unfavorable conditions, even considerable parts of the desert may be improved by science. History gives many illustrations of the fact that countries once deemed of little worth became the seat of prosperous states in after years. At the beginning of the sixteenth century, few in Europe would have thought North America worth settling, yet that fertile area is now our home.

IN NORTHEASTERN AFRICA.

Excepting Abyssinia and the two Italian possessions on the coast, the combined area of all being 617,662 square miles, all of Northeast Africa is a part of the British empire. The total area is 1,859,040 square miles, or nearly two-thirds as large as the continguous portion of the United States. The population is given roughly, of course, as 21,000,000.

EGYPT

Four hundred thousand square miles are ascribed to Egypt, but the settled portion is all contained in the Nile Valley and the delta comprising a trifle over 12,000 square miles. That section is one of the most densely settled portions of the world, being 931 to the square mile. However, the three cities of Cairo, Alexandria and Port Said are what influence that enormous total. It is safe to say there is not a more interesting section of the earth than the valley of the Nile, now under British control. This was one of the oldest centers of civilization. Probably as early as 5,000 B. C., many civilized tribes settled along the Nile, were united in a powerful confederacy which appears in history as the Egyptian Empire, and for more than four thousand years that narrow valley was the home of a highly civilized, powerful and influential people. Massive pyramids still towering in air, mark the resting place of Pharaohs who ruled in Memphis nearly 6,000 year ago. The mournful ruins of imposing temples at Karnak have witnessed the flight of thirty-five centuries. In the museum at Boulak we gaze upon magnificent specimens of artistic work of a time when Athens was unknown. All this belongs to a forgotten past, and a people of a foreign race, from a country that was the home of barbaric tribes utterly unknown to the ancient people, now administer the affairs of this wonderful country.

THE GREAT PYRAMIDS.

Not least among the wonders of the world are the Pyramids of Egypt. These stupendous monuments of an ancient dynasty stand on the right bank of the Nile, a few miles from Cairo. The eye follows with amazement the graded lines of the prodigious masses, showing in the light the profile of their rugged slopes, disposed in flights of fractured steps. They resemble mountains hewn into square blocks rather than structures raised by mortal hands. There are three Pyramids at Gizeh, that of Khufu, known as the Great Pyramid, is the largest of the three, covering an area of over twelve acres, while its four triangular sides present altogether a surface of no less than twenty acres. A quantity of material measuring 90,000,000 cubic feet was brought from great distances by way of the Nile, placed on the rocky foundations, raised to a height of over 500 feet, and adjusted with the greatest care. Its present height is about 456 feet. The height of Cepheren, the second pyramid, is about 450 feet; while that of Menkara, the third, has less than one-half of these elevations. There are several other pyramids of smaller dimensions at other places along the Nile. Once some seventy massive pyramids confronted that river, all except a few, such as the pyramid of Sakarah, have been destroyed. The three named are known as the Pyramids of Gizeh, which is a village in the vicinity. They were constructed during the Fourth Dynasty, which began about 4,000 years B. C. Travelers often ascend the Great Pyramid before dawn in order to contemplate the morning sun lighting up the vast spaces of the desert in one direction, while in another are the verdant plains with their dark groups of hamlets, and the silver lakelets left by the lost overflow of the Nile. It is generally agreed that the pyramids are royal tombs.

THE GREAT PYRAMID.

GOVERNMENT.

From the earliest time, Egypt has been divided into two principal divisions. One of the titles of the Pharaohs was "Lord of the two countries." Modern usages still continue this division and we have Upper and Lower Egypt. For administrative purposes, each in turn is divided into provinces, as in earlier times the country was divided into nomes, and by a stranger coincidence still, there are as many of these modern administrative divisons as there were nomes in the days of Menes, who first united the country under one ruler, seven thousand years ago.

CLIMBING THE GREAT PYRAMID.

ANCIENT EGYPTIAN CIVILIZATION.

Ancient Egypt was united by trade, war and diplomacy with all the countries about her. The civilized world of the ancient East was not so very much unlike the civilized world of to-day, and Egypt was easily at the head of that ancient civilization. The ruins of an ancient city, unearthed in 1913 in North Sudan, proved to be the center of an extensive iron industry. There were discovered ruins of old smelting furnaces that must have been capable of supplying the ancient world with iron. Beautiful pottery ware was also a product of that ancient city. Cups and bowls of biscuit ware were found as fine and thin as the famous eggshell ware of China, though not translucent. We of to-day—in culture—are much nearer those men of old Egypt than to the half civilized Europe of Middle Ages. It is known that caravans from China anad India often visited Egypt. Babylonia, on the east, was the other great center of early culture. Civilization spread from these two centers into Europe.

AGRICULTURE.

Agriculture always has been the principal industry in Egypt, and the valley of the Nile, irrigated by the yearly overflow of that river, is one of the most fertile in the world. Of course, every one knows that rain never falls in Egypt, and that the Sahara would include in its grasp all Northern Africa, were it not for the Nile, which is fed by the rains of Equatorial Africa, and has marked its course by a meandering belt of green across the sands of the Libyan desert, which fertile valley is the Egypt of old. Three crops are grown yearly and every acre of ground capable of cultivation is used. Cereals of all kinds are sown in November, and harvested in May and June; cotton, sugar and rice are sown in March and harvested in October and November; while rice, maize, millet and vegetables are sown in July and gathered in October and

November. Sugar and cotton are the principal articles of export. In 1912 the equivalent of over 1,300,000 bales of cotton was exported. The cotton is a long staple variety, more valuable on that account than the common cotton of the United States.

IRRIGATION.

Irrigation has been practiced in Egypt from the very earliest times. Thousands of years ago, the Egyptians had covered the Delta with a network of canals. Also at a very early date the extensive section of the Fayoum, south of Memphis, was irrigated by canals supplied with water from the Nile. It has, however, remained for modern times and the genius of British engineers to construct one of the greatest engineering feats of modern time and thus make possible the irrigation of an enormous area.

IRRIGATION OF THE NILE REGION

BARRAGE AT ASSIOUT—2,750 FEET LONG.

SOUTH OR UPSTREAM SIDE OF THE DAM AT ASSOUAN, FROM VEST BANK.

Total length, 1¼ miles; maximum height above foundation, 180 feet; difference of water level above and below, 67 feet. Total weight of masonry, over 1,000,000 tons.

The monumental dam at Assouan, which is by far the greatest achievement of its kind in ancient or modern times, forms a reservoir in the Nile valley capable of storing 1,000,000,000 tons of water, practically creating a lake more than 140 miles long. The foundation stone was laid by the Duke of Connaught on February 12, 1899. At times fifteen thousand men have been employed, and work has gone on day and night. At other times, when the Nile was in flood, labor had to be suspended for several weeks.

One gains a clearer idea of the magnitude of the task by recalling the first step taken; that was, to divert the channel and excavate in the rocky river-bed a trench one hundred feet wide and as many feet deep, in which to lay a concrete foundation for the massive piers.

At its best, and controlled, the Nile is very generous, as befits the majesty of its three thousand miles. Joseph the Israelite drew some of his prosperity from it. One of the irrigation canals he planned for Pharaoh's people is still in use. But in most moods the Nile is a sullen and inconstant stream, and even in the days when Egypt was the granary of imperial Rome there seems to have been no comprehensive attempt to govern it.

Napoleon had a faint perception of the thing that needed to be done when he suggested a dam near Cairo. That, he realized, would double the cultivable area around the river's mouth. In the earlier portion of the 19th century two barrages were actually built at that spot by a French engineer—badly built, however, and useless until, of recent years, the British reconstructed them. This work consists, in effect, of two brick arched viaducts crossing the Rossetta and Damietta branches of the Nile, having, together, 132 arches of 16-feet-four-inches-span, which were entirely closed by iron sluices during the summer months, thus heading up the water about 15 feet and throwing it at a high level into the six main-irrigation canals below Cairo. In the summer months the whole flow of the Nile is arrested and thrown into the aforesaid canals.

THE GREAT DAM AT ASSOUAN.
Entrance to locks of navigation channel from the south.

The most important of the works constructed to enable the water stored up in the great reservoir to be utilized to the greatest advantage is the barrage across the Nile at Assiout, about 250 miles above Cairo, which was commenced by Sir John

Aird & Company in the winter of 1898, and completed in 1902. In general principle this work resembles the old barrage at the apex of the delta; but in details of construction there is no similarity, nor in material, as the old work is of brick and the new one is of stone. The total length of the structure is 2,750 feet, or rather more than half a mile, and it includes 111 arched openings of 16 four-inch spans, capable of being closed by steel sluice-gates 16 feet in hight.

The object of the work is to improve the perennial irrigation of lands in Middle Egypt and the Fayoum, and to bring an additional area of about 300,000 acres under such irrigation by throwing more water at a higher level into the great Ibrahimick Canal, the intake of which is immediately above the barrage.

The total length of the dam is about a mile and a quarter; the maximum height from the foundation is about 130 feet; the difference of level water above and below, 67 feet; and the total weight of masonry over 1,000,000 tons. Navigation is provided for by a "ladder," of four locks, each 260 feet long by 32 feet wide. As with the case of Assiout, the difficulties in dam construction are not in design, but in the carrying out of the works. When "rotten rock" in the bed was discovered, Sir Benjamin Baker frankly reported to Lord Cromer that he could not say what the extra cost and time involved by this and other unforeseen conditions would be, but that, however bad the conditions, the job could be done. He was told to go ahead with the work.

The first channel was successfully closed on May 17, 1899, the depth being about 30 feet and the velocity of the current about 15 miles an hour. In the case of another channel, the closing had to be helped by tipping in railway wagons themselves, loaded with heavy stones and bound together with wire ropes, making a weight of about 50 tons—this great mass being necessary to resist displacement by the torrent. These rubble dams were well tested when the high Nile ran over them; and on work being resumed in November, after the fall of the river, water-tight sand-bag dams, or "sudds," were made around the site of the dam foundation in the still waters above the rubble dams, and pumps were fixed to lay dry the bed of the river.

THE NAVIGATION CHANNEL ENTRANCE LOCKS FROM THE NORTH.

This was the most exciting time in the early stage of the operations, for no one could predict whether it would be possible

WEST AFRICAN POSSESSIONS

On the northern shore of the Gulf of Guinea, the continuity being broken by the independent republic of Liberia and the French and German possessions, are four dependencies of Great Britain, Nigeria, Gold Coast, Sierra Leon and Gambia, with a combined area of 444,000 square miles, with a population exceeding 20,000,000. In all, the West African possession areas are as large as all the states of the United States that border on the Atlantic, including Pennsylvania, and throwing in Alabama for good measure.

INDUSTRY.

All that can be said about the West African possessions is that the land is generally fertile, though the climate is not healthy for Europeans in much of the territory. There is a great deal of valuable timber, such as mahogany, in the western part. The Gold Coast received its name on account of rich gold deposits. In Nigeria, there are extensive mines of tin, and though mining is carried on in a primitive manner, in the last census year about 1,500 tons of tin was produced, and it is thought this industry will soon become very prosperous. Kano, in Nigeria, is the point to which caravan routes from distant points, even across the Sahara, gather, and thither they come from central Africa also. These caravans are at times very large and carry immense amounts of merchandise. The captain of the caravan has as much authority as the captain of a ship, and strict military order is necessary to escape the robber bands of the desert and jungle. The products generally are rubber, palm oil, cotton, cocoa, coffee, ivory, hides and fruits. In the last census year, the total foreign trade movement of the West Coast possessions by way of the sea, was about $125,000,000. There does not seem to be any great future ahead of this possession except the improvement that always accompanies an increase in general enlightenment. And the government is doing its best to educate the natives, especially in practical matters, such as agriculture and forestry.

SOUTH AFRICA

Excepting Portuguese and German possessions along the coast, a total area of about 1,000,000 square miles, all of Africa, south of the Belgian Congo, is a part of the British Empire. It is an area of some over 1,200,000 square miles, or about two-fifths as large as the United States, not counting Alaska. According to the last census the population is 8,375,000, the most of whom are natives, hence low in the scale of development. For administration purposes, this extensive tract is divided into Basutoland, Bechuanaland, Rhodesia, Swaziland and the Union of South Africa. This last division is composed of four older colonies: The Cape of Good Hope, Natal, Transvaal, and Orange Free State. Without going into the history, let us state that these colonies were settled by people of Germanic descent, and their consolidation into one province was preceded by a very stubborn war between England and the Boer settlers. The Union is governed by a lieutenant-governor, appointed by the crown, and a parliament composed of two houses. Each province of the Union exercises local self-government. The other provinces are variously governed; in places the native chiefs exercise authority, but under the supervision of British commissioners.

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VICTORIA FALLS, ZAMBESI RIVER.

AGRICULTURE.

As a whole, the country is suited for grazing purposes, and that is the principal industry. The water supply is not abundant in any of the provinces except Basutoland, but the government is making great efforts to conserve the water supply, and in some districts, very large and costly schemes of irrigation have been undertaken in some cases by private enterprises, in others by corporations. Among the items of export, wool is most important. In the last census year, about 175,000,000 pounds were exported. It is also interesting to note that over $13,000,000 worth of ostrich feathers were exported. Rubber will soon be a very important article of export from northern Rhodesia, the rubber forests there cover about 21,000 acres, and the vines are strictly protected.

MINING.

In 1885 gold was discovered in that part of the Transvaal called the Rand, and that section is to-day the greatest gold producing section known, producing about 25 per cent of the total gold supply of the world. There is no immediate danger of exhausting the deposits, since the gold bearing strata extend far north into Rhodesia. Here and there are evidence of ancient mining by unknown people, centuries ago. Thus two of the great gold fields of the world, Australia and the Rand, are in British territory. South Africa contains the only important diamond mines in the world, diamonds being found in large quantities near Kimberly, northern part of Cape Colony, in the Orange River country. The richest diamond mine ever known is the Premier mine, near Pretoria in the Transvaal. In the last census year over $250,000,000 of gold and diamonds were exported from South Africa.

On the Zambesi River, near the southern boundary of Rhodesia, is the greatest waterfall in the world, the Victoria Falls. The river at the falls is one mile wide. The chasm extends the whole breadth of the river, and is more than twice the height of Niagara. The volume of water is not, however, constant, as it is at Niagara. An enormous amount of power is here going to waste, enough to electrify all of South Africa, and some day it will be utilized.

THE FUTURE.

Geologically speaking, South Africa is a very old country, and the erosive forces of nature have been at work for a very long time. For thousands of years, however, it has been the home of non-progressive tribes. Cape Colony has been an English possession only a century. The most of the British possessions have been acquired within the last fifty years. In that time great progress has been made and it seems safe to prophesy a prosperous future. Mining is active and the deposits of all kinds of minerals are very great; railroad development is growing—there are now about 8,000 miles of the South African system under government control—and settlers are pouring in, a good many thousand every year from the United Kingdom. In all ways the country is developing. Education is given careful consideration, especially agriculture. We may look for Southern Africa to be one of the most prosperous sections of the British Empire in the not distant future.

FRANCE

France in Europe is only a fraction of the total area of the republic. We have to do with a country of which the nucleus only is situated in Europe, since the area of France is but a little over 4 per cent of that of the foreign possessions. We must not forget that the larger part of the United States was a French possession a little over a century ago, and that fifty years earlier, all of the immense area of Canada belonged to France also, and even to-day, French is the prevailing language in the largest of the nine provinces of Canada, and the official publications of Canada are printed in French as well as English.

The area of France is 207,054 square miles, and the population 39,601,509, or 190 to the square mile. The question of population is a very vital one. Unlike its neighboring countries, population in France is almost at a standstill. The surplus per thousand of births over deaths is only a little over one and a half. In Germany, the surplus is over thirteen and a half per thousand, and the population of that country per square mile is 310.

France has had a most interesting history. For long centuries she was the leading country in Europe in arts, general refinement, influence and power, and French was the language of diplomacy. The great city of France is Paris, with a population approaching three million, in the last census, being 2,888,110. It is certainly one of the most beautiful cities in Europe, and of great historic interest. Just about one-fifth of the total area of France is forest, about one-seventh is returned as uncultivatable, but every acre of the 90,314,246 remaining is put to good use; and the last census returned 949,000 as agriculturists. All of the principal crops are raised. The vineyards are very extensive, and nearly a billion gallons of wine is annually produced. The mining industry is very important, lead, zinc, copper, coal and iron are all mined in quantities. Silk culture is carried on in twenty-four of the departments, and the last census year, about 13,000,000 pounds was produced. There are about 25,000 miles of railroad, and France has spent vast sums in building up her canals and improving her rivers. About 4,000 miles of splendidly built country highways radiate from Paris to the principal cities of the republic.

STATION OF THE PARIS UNDER GROUND RAILWAY.

THE GOVERNMENT OF FRANCE

France, in its government, has been a mass of anomalies. From the extreme of monarchy to the extreme of theoretical republicanism, this country has swung back and forth repeatedly. Naturally, therefore, the results of these mutations are to be found in its present government. When the aristocracy of France was put under the guillotine and the monarchy was snuffed out with Louis XVI., the masses, afraid to trust single persons, caused boards of management to be appointed. When Napoleon came upon the scene, he dominated through numbers of trusty tools. Then came changes to republic and empire, with the constant and considerable power of a great army always a factor in either kind of government. No study of the government of France is complete that does not take into consideration the great confidence placed in the army and the enormous power wielded by it. To-day, under the third republic, there is a constant struggle for supremacy between the monarchical and the republican idea of government. While France may be considered most advanced in theoretical republicanism, yet the long sway of aristocratic ideas militates against placid democracy.

COLUMN OF JULY.
Commemorating the fall of the Bastile and the rise of the Republic in France.

THE NATIONAL ASSEMBLY.

The immediate forerunner of the present form of government was a national assembly, elected to treat with Germany in 1871, after France had been humiliated in the Franco-Prussian War. This assembly found itself in control of the situation, and, while its members were largely monarchical in their views, seeing the tendency of the people toward republicanism, they framed a meager constitution and put it into effect without reference to the people.

METHODS OF ELECTION.

France has three branches of government—legislative, executive and judicial—yet they are so strongly centralized that they may not be compared with similar branches in other republican forms of government. For elective and administrative purposes, France is divided into 86 departments which are divided into 362 smaller districts, which are, in turn, divided into 2,911 cantons, and these are subdivided into still smaller divisions called communes, of which there are 36,229.

A chamber of deputies, made up of 597 members elected for four years, and a senate whose members are elected for nine years, one-third retiring every three years, make up the legislative department.

ELIGIBILITY TO OFFICE.

Every male citizen 21 years old, who is not disqualified and who has lived six months in a commune, may vote. Deputies must be 25 years old; they receive $1,800 a year and have free transportation on all railroads. These men, generally, are retired merchants, doctors or farmers, and are of only ordinary attainments. Senators, to be eligible for that office, must be 43 years old; they receive the same salary as the deputies. Ordinarily, their age is over 60 years. Deputies are elected directly from their districts, though some of these districts are large enough to elect two or more. The elections are held on Sunday. In case no candidate has a majority of votes in an election, nor receives one-fourth the number of registered votes in his constituency, another election is called for two weeks later. Then a plurality elects, and in case of a tie, the oldest of the candidates is chosen. Senators are chosen by electoral colleges and come from the departments. These colleges are composed of members of the council general of the department and of the different councils of the districts of the department, senators and deputies of the department, and electors chosen from the municipal councils of the numerous communes of the department; retired professional men of the country towns are generally elected. The duties of the senate extend principally to advising with the President as to when the chamber of deputies shall be dissolved, and in sitting in his high court in case of impeachment for grave offenses against the state. In most instances, the senate is the inferior body of the legislature.

THE PRESIDENT AND HIS CABINET.

The executive department is headed by the President who may never be a member of the royal family, and who is elected by the chamber and senate sitting in joint session. His salary is $125,000 a year; he has a great retinue of servants, and has free use of the great "palais d'elysees" of Paris. He does not have the veto power on legislation, yet he may return bills for a second vote. He may adjourn the houses for one month, may close a session that has lasted over five months, and by the consent of the senate may dissolve the chamber of deputies. The cabinet of the President is made up of the heads of 11 departments, such as war, finance, marine, etc., who receive a salary of $12,000 a year. These advisers of the President are chosen generally upon the recommendation of the presidents of the two houses They are members of the two houses and wield considerable influence. The members of the cabinet frame legislation, sanction the acts of the President, in order to make them valid, and speak in both houses, whether they are members of both or not. When they cannot control legislation, they resign and a new cabinet is chosen. Although the President is elected for seven years, and the life of the average cabinet is less than a year, yet the government is rather by the cabinet than by the President, who has little real power and is largely a luxurious figurehead.

THE SENATE AND CHAMBER OF DEPUTIES. MODE OF LEGISLATION.

When each annual session is begun in the chamber of deputies legislation is started by the choice, by lot, of eleven bureaus, while the senate selects nine in the same manner. A committee for parliamentary initiative is chosen from these bureaus to serve one month, to which are referred all measures when presented. This committee decides whether they are worthy of consideration. It considers a bill, has it printed and presents it to a subcommittee of the respective bureaus for further consideration along party lines. When the bill has been thrashed out to suit the views of the committee, it is presented before the house by a commissioner who reads it from a little gallery called a tribune, which is located just above and behind the desk of the president of the house. The speaker of the house, unlike the corresponding officer in the United States house of representatives, has little power. Parliamentary usages in France are very crude and members and even the president of a house will resort to trivialities, epithets and even violence in open session.

THE COUNCIL OF STATE.

The council of state, a relic of the days of Napoleon, is another body. It is made up of professional men who simply give their opinions on profound subjects for legislation, but it is rarely followed.

FAVORITISM AND SUBSIDY.

Favoritism and subsidy go hand in hand in the administration of affairs. Power in France is the main thing sought after by members of the government. The cabinet, in order to retain the good will of the chamber of deputies, upon whose whim it must stand or fall, deals out many favors in the way of offices, etc., to the minor members. The good will of the public also must be maintained in order to hold seats in the houses, and great sums of money, placed in the hands of the government for secret-service work, are frequently spent in bribing influential newspapers to support the officials of the administration.

THE JUDICIARY.

The judiciary of France differs widely from that of other countries. In her courts a man often is considered guilty until proved innocent. There is no grand jury, one judge sitting in private and deciding whether cases shall or shall not be brought to trial. The system of courts starts with the usual local justices of the peace, and ascends through courts of appeals to the final supreme court. The President, with the aid of the minister of justice, appoints the judges who, except the local justices, hold office during life. There is a special court made up of men of expert training to decide disputes within the administration, or between citizens and officers. Many courts, whose jurisdiction covers cases where sentences of but three or four years imprisonment may be imposed, are made up of three judges, who sit without juries. Higher courts have the adjunct of twelve jurors, who decide cases by a majority vote. Commercial cases are tried before special courts, made up of experts.

CENTRALIZATION OF POWER.

To show how centralized the whole government of France is, it may be stated that even in local government the prefect or governor of each department is appointed by the President and is answerable to the cabinet. This officer is assisted by a general council elected for six years, and consists of one representative from each Canton. These govern schools, railroads, local courts and asylums. In like manner, the District or arrondissement, the next smaller division, has a subprefect appointed by the prefect of the Department, responsible to him, and really acting as his agent. The work of dividing the taxes among the Communes is done by a council, which is made up of a member elected from each of the Cantons.

THE CANTON AND THE COMMUNE.

The Canton is simply a small division for election and judicial purposes, and is a muster center of the army. The smallest division of the governmental system, the Commune, is really the unit of French government, as it is the most democratic of all. It elects its municipal council according to its population, and this council elects its mayor. But after the mayor is once elected, he immediately becomes the agent of the central government at Paris, and can be removed at will. Thus we see the possibility of the great central power exercising despotic will for a considerable period. Finally, however, elections occur, and other officials are put in who may reverse for a time the trend of affairs. While there is much knavery in French politics, the central government shows great enterprise in the matter of magnificent roads, bridges, public buildings, expositions and educational institutions.

FRENCH ASIATIC POSSESSIONS

All of the peninsula of Indo China, which juts from southeast Asia into the China Sea, separated from the Malay peninsula by the Gulf of Siam, is French Territory, except the Kingdom of Siam itself, but the French possessions, comprising an area of 310,000 square miles, is more than twice the area of Siam. It is a territory somewhat larger than Ohio, Indiana, Illinois, Iowa, Missouri and Kentucky combined. The population is some over 16,000,000. As a rule, French possessions do not enjoy as full a degree of self-government as those of Great Britain, as is illustrated in the government of Indo-China. At the head of this possession is the governor-general, appointed by France, assisted by a secretary-general. There is no legislative assembly—the several divisions of the country are still nominally under the rule of native kings who, however, rule as directed by the French officials. These divisions are: Annam, Cambodia, Cochin-China, Tonking and Laos.

RESOURCES.

These provinces vary among themselves as to fertility and natural resources. As a rule, irrigation is practiced on an extensive scale. The principal products are rice, valuable timber, rubber and raw silk. Manufacturing industry is feeble, but there is considerable mining, mostly coal and zinc. The foreign trade movement in the last census year was about $50,000,000. Future advance is dependent upon the spread of modern education and enlightenment.

FRENCH AFRICAN POSSESSIONS

It is a surprise to many to learn that French possessions in Africa are nearly a million square miles greater than those of Great Britain in the same continent. This is the case after placing in the British column, 1,384,520 square miles representing the area of Egypt and the Anglo-Egyptian Sudan, and making the necessary corrections for the agreement between France and Germany in reference to Morocco and the Congo in 1912.

Thus corrected, the French possessions reach the enormous total of 4,541,934 square miles, or an area one and a half times as great as that of the United States, not including Alaska.

THE SAHARA DESERT.

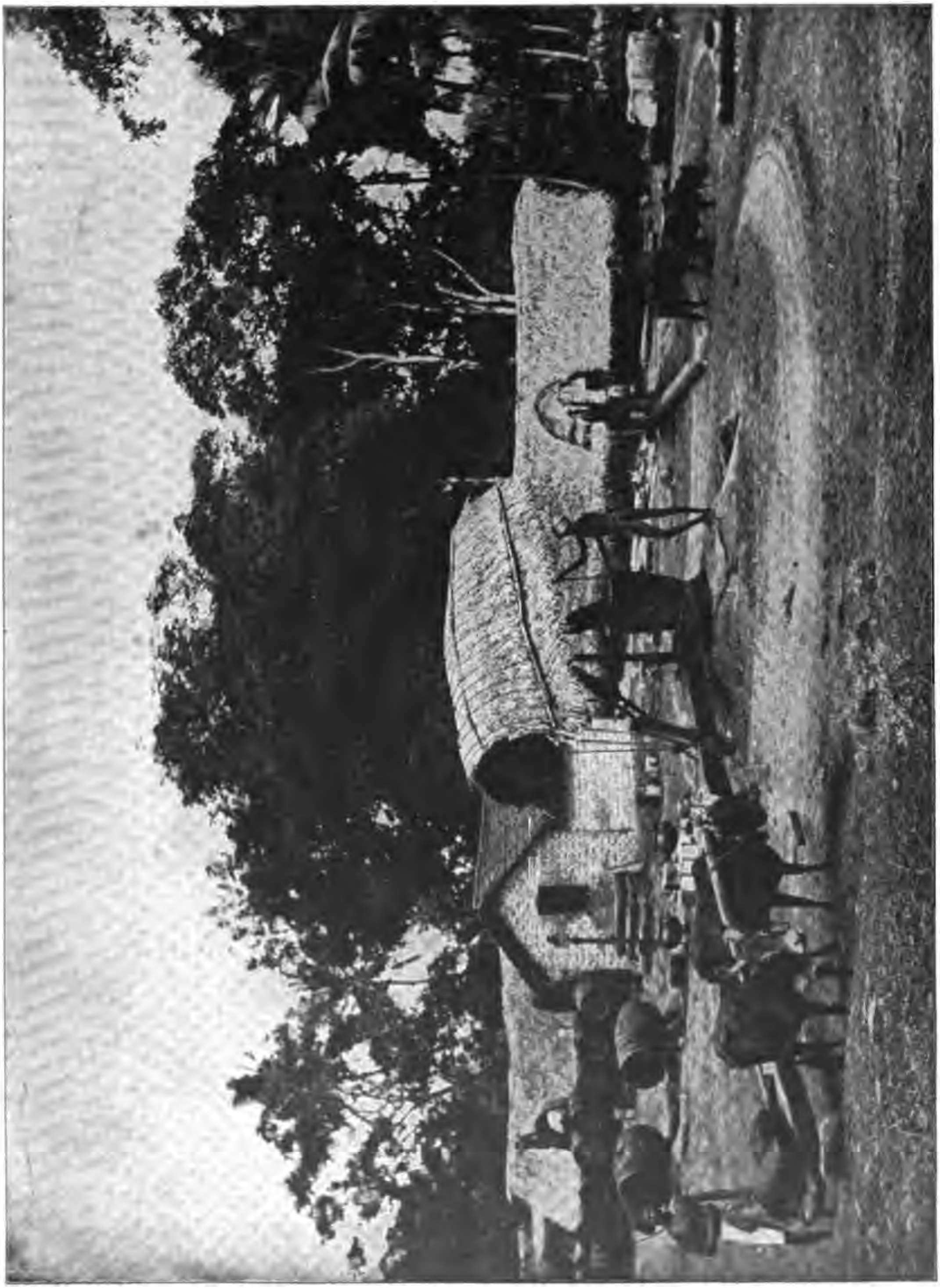
However, a third of that extensive area is included in the Sahara desert, where only a few oases support life. In area, the desert is 1,544,000 square miles. The population of the various oases is between 800,000 and 1,000,000. It is difficult to imagine the Sahara ever being anything more than a desert, but the science of the future may, in some way, restore large sections to fertility. It is not a flat waste of sand. On the whole, it is an elevated plateau, 1,600 feet above the sea, only in a few places is it as low as 500 feet above, thus the old idea that it could be easily flooded with water from the ocean is an error. Across it, from oasis to oasis, are well defined caravan routes, leading from equatorial west and east Africa, to the French possessions on the north.

ALGERIA.

The northwest coast of Africa, including Tunis, Algeria, and since 1911, Morocco, is a French possession. Algeria is regarded as a part of France, and sends senators and deputies to the national assembly at Paris. The combined area of these provinces is 608,279 square miles. It is a vast section of country, as large as our Pacific states, and Idaho, Montana and North Dakota in addition. Roundly speaking, the population is 12,000,000. Morocco has so recently passed under French protection that it was not officially included in the list of French possessions, but as a result of the World War it is now included.

RESOURCES.

In early centuries, in the days of the Roman Empire, this section was a prosperous province, and many ruins dating from Roman times still exist. Much of Tunis is fertile; but only parts of Algeria are, the sections in the south being arid. Large parts of Morocco are fertile, but the interior is but little known. In all, agriculture is the principal industry. Olives, olive oil, and dates are exported, and in all, rich mineral deposits are known to exist. There are many thousand acres, covered with forests of cork-



EXTRACTING COCOA OIL—PROCESS OF MANUFACTURE.
Copra—the Inner Kernel of the Cocoanut—is ground for Cocoa Oil.

oak and from thence comes much of the world's supply of cork. Mining phosphate rock for fertilizers is an industry that will probably be very large in the future. As Algeria is a part of France, soldiers from that country participated in the great European war. There seems to be no reason why the prosperous condition of early centuries should not again bless this whole section. A strong government insures political stability, railroad development insures improved inland commerce, and education and general enlightenment will bring in their train the usual blessings. Being near to Europe, a desirable class of emigrants are passing into the country.

FRENCH EQUATORIAL AFRICA.

The French Congo is also the name of a large possession in equatorial Africa, which comes to the east coast of the Gulf of Guinea and flares out to the northeast, north of the Belgian Congo and east of the German Kamerun. Its total area is about 669,000 square miles, with a population of about 10,000,000, mostly negro tribes. In the future, this may become a valuable possession, since it has great forests of rubber trees. The mineral resources include gold, copper and iron. The Congo is one of the great navigable rivers of Africa, and gives access to the very heart of the continent.

FRENCH WEST AFRICAN POSSESSIONS.

England, Germany and Liberia have monopolized most of the north shore of the Gulf of Guinea, but back of these coast possessions, losing itself in the desert of Sahara, to the north is another vast possession of France which comes to the shore of the Guinea Gulf in the Ivory coast, to the east of Liberia, and the narrow prong of Dahomey, between the German Togoland and the British province of Nigeria. North of Sierra Leon, it borders on the Atlantic Ocean. This immense territory is 1,585,810 square miles in area and contains a population of 11,100,000. Some time this territory may be a valuable province, at present it is the home of partially civilized tribes and it will be a very long time before the education and enlightenment necessary to modern civilized states will permeate it, though the government is doing what it can to diffuse education among the natives. There is, however, nothing to attract desirable immigrants to this section, as there is to South Africa, and to a lesser extent, to the French possessions in the north.

FRANCE AND THE WORLD WAR

Without attempting to describe the terrible ordeal through which France passed in the world war, it remains to consider conditions in France as they were affected by the war itself. Though every nation in Euorpe was profoundly affected by the results of the war, France was influenced in a special degree being exposed to the full fury of the invasion. This influence, in turn, left an indellible impress on French character.

INCREASED STRENGTH OF NATIONAL TIE.

The foreign possessions of France though small compared with those of England are important; and, on a smaller scale, the same

The Hall of Mirrors in the Palace of Versailles results followed in France as in the former country. All the North African possessions hurried troops to the assistance of France. Soldiers from Algiers, Tunis, and Morocco fought side by side with the soldiers of the allied countries. From the French possessions in the far East came reinforcements to the common cause. These soldiers returned to their homes with a new sense of the importance of France with new ideas as to Western civilization, with a feeling of pride that they, also, form a part of the republic. Life was quickened in all their possessions. A greater France was born in the bloody turmoil of the world war. It became a trite saying that France found her soul in the war. It could not be otherwise. No nation whose soldiers die as did those of France at Verdun, or whose citizens make such sacrifices for the good of the state can be deprived of a great uplift in thought; and on higher planes of action France entered on the new era that has since confronted the world.

INCREASE OF TERRITORY.

Alsace and Lorraine, torn from France at the conclusion of the Franco-German War of 1871, were returned to France. The combined area of these two provinces is 5,604 square miles, with a population, at the latest available census, of 1,814,564. The great value of these provinces lies in their rich mineral deposits. Seventy per cent of the iron mined in Germany and which made Germany strong industrially, came from Lorraine. And there are rich deposits of potash yielding ores in Alsace. Before the war, Germany had almost a monopoly of potash. This wealth of natural resources reverted to France. In Paris stands the Strassburg Monument, a memorial of Alsace. For nearly fifty years it has been draped in mourning, in memory of a lost province. It is now bright with tri-colors, signifying the return of these provinces to the home country.

THE PALACE OF VERSAILLES.

Twelve miles from Paris is the ancient town of Versailles, of interest as the site of the world famous palace of Versailles. Two centuries and a half ago, Louis XIII had at this place a hunting-seat. Louis XIV—whose reign of glory and of shame—formed the pinnacle from whose height France declined to the pitiful times of the French Revolution—caused that hunting lodge, of no great moment, to be transformed into the Imperial Palace of Versailles that remains the most celebrated palace in Europe. For more than a century, here was the home of French royalty; here Louis XVI brought his beautiful bride, Maria Antoinette, and here they lived until the troubled movements of the Revolution drove them to Paris—and to death.

The palace consists of a central block and two great wings, surrounding three sides of the Court of Royalty and the Court of Honor. The total length of the palace and its connecting buildings is nearly half a mile. In the central block with its garden facade, among other wonderful rooms is the Gallerie des Glace, or Hall of Mirrors, the subject of our illustration. In the long north and south wings are imposing corridors filled with statuary, there are chapels and theaters, there is the gorgeous Gallery of Battles—130 yards long, the Gallery of the Empire, and the Hall of the Crusades filled with modern paintings of the Crusades, and innumerable rooms some of which are of great magnificence, adorned with paintings

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A FEUDAL CASTLE IN GERMANY.

The building here shown is a modern structure, but it occupies the site of a Feudal Castle built by Count Thassilo Von Zollern, the founder of the House of Hohenzollern, more than eleven hundred years ago.

by artists of the 17th century and later times. The whole palace is a vast museum of French history and art.

Flushed with their great victory, German royalty and nobility, generals and diplomats —clad in the flashing regalia of war—came to the Hall of Mirrors, January 18th, 1871, and there William I was crowned Emperor of a United German Empire; in that hall also was signed the treaty of peace that put an end to the Franco-German war of 1870. Nearly fifty years passed and once again in that historic hall was signed a notable treaty —perhaps the most momentous one in history—the treaty officially terminating the world war of 1914. This time the treaty was the occasion for, not the formation of an empire, but of a League of Nations, the first in history, and which constitutes what is perhaps the greatest forward step ever taken in history, for outclassing the celebrated Achian League, such a striking event in the days when authentic history was beginning.

Thus, by strange circumstances this magnificent palace, this marvelous Hall of Mirrors, so intimately connected with stirring events in French history is equally connected with great events in the history of the world,—the rise and fall of the German Empire; the conclusion of the greatest war that ever convulsed this planet; the formation of a league of nations, the starting point of a new epoch in history, destined to bless all mankind.

THE RECENT GERMAN EMPIRE

We must glance at the history of Germany for she was but recently a commanding figure in European affairs. The fate that befell her illustrates once more the vicissitudes of time and emphasizes again the lesson that nations no more than individuals can build an enduring edifice of greatness on a foundation morally weak.

The early history of Germany is a confused panorama of a thousand years, during which Central Europe was the country of numerous separate states, many of them at times coming together as a more or less closely-knit confederacy, under the hegemony of a powerful state, only to fall apart into a mass of struggling units at a later date. Into the details of that interesting period of time we need not enter. The German Empire in its greatest extent consisted of a union of twenty-five separate states, kingdoms, principalities, electorates and so on,—and the reichland of Alsace-Lorraine. The combined area of these states is 208,780 square miles. It should be noticed that Texas could furnish that area and have enough territory left to form a state as large as Florida.

OUTLINE HISTORY OF GERMANY.

An outline of the recent German Empire is interesting. Prussia was the principal state of those composing the empire, ex-officio the king of Prussia was also the emperor of Germany. The foundation of Prussian greatness was laid by Frederick the Great in 1763 when he wrested Silesia from Austria in an entirely unprovoked war. A century later, Bismarck, the Iron Chancellor, conducted three victorious wars, not one of which was justifiable; on the contrary every one was undertaken to increase the territory and political power of Prussia.

In 1871, as a fitting climax to this series of wars, there was organized the German Empire with Prussia as the leading state, with the right of succession to the imperial throne made hereditary in the reigning house of Prussia. Thus there suddenly arose in Central Europe, in the place of the weak confederation of earlier years, one empire of great actual strength, generously endowed as regards territory, at the head of which was a state which alone of modern states most resembled the Rome of early centuries that eventually ruled the Mediterranean world, imposing on the conquered people of that section, her language, her laws, and her customs. And like that Latin state we now know that Prussia regarded all she had accomplished to the formation of the German Empire as only the first station reached in a career of triumph which was to end in a world empire as greatly surpassing that of Rome in her palmy days as the world of the twentieth century surpassed the known world of Roman times.

THE GOVERNMENT OF GERMANY.

In earlier years the government of the German Empire was often spoken of as being a limited monarchy. It was, as a matter of fact, a military autocracy, over which the King of Prussia ruled with almost absolute sway, holding theories of government long outgrown by the advanced nations of Europe. As the ex-Kaiser asserted, he regarded himself as divinely commissioned to rule his people and in that conviction he declared he went his way, crushing all who opposed him. "There is only one master of the nation; and that is I, and I will not abide any other." Nor were these words the idle boast of an enthusiast. The kaiser not only devoutly believed them, but the leaders of German thought admitted the claim, and the constitution of the empire was drawn subject to them.

THE REICHSTAG.

The Reichstag was the name of the lower house of the German parliament. It was often compared to our house of representatives in Washington. "It was," says Ambassador Gerard, "nothing but a debating society because of the preponderating power of the bundesrath." The reichstag consisted of 397 members. Of that number 236 (a majority) represented Prussia. Owing to a vicious system of circle voting the military ring, the junkers, absolutely controlled the Prussian delegates. In other words, the kaiser controlled the majority of the reichstag.

The bundesrath was often compared to our senate; here again the resemblance was remote. The members of the bundesrath were ambassadors, one or more from each state of the German Empire, that met to consider questions of interest to the empire. The numbers varied. There were fifty-nine votes in all. Prussia cast seventeen and absolutely controlled two more. No other state of the empire cast more than six votes; the majority of the states cast but one vote each. The chancellor was appointed by the kaiser and was responsible only to the kaiser; all the other ministers were appointed by the chancellor. An analysis of these statements shows with what autocratic power the kaiser ruled his empire.

THE DEVELOPMENT OF THE EMPIRE.

The German Empire was organized in 1871. It ceased to exist as an empire in 1918. Thus a period of only forty-seven years embraced its cycle of history. It was a period of marvelous development in all the elements of material greatness. During that time was acquired a colonial empire in area nearly five times the size of the original empire. Their colonies were situated mainly in Africa and included large sections of fertile land and immense forests of valuable timbers. In area the African colonies were larger than all of the United States east of the Mississippi River. Germany also controlled a large number of islands in the Pacific, aggregating nearly 100,000 square miles in area. In days to come, when the Pacific shall be the theater of vast ocean transport, these islands, advantageously situated, possessing many fine harbors, would have been a most valuable possession.

AN AUTOCRATIC POWER.

In the democratic nations of Europe—as represented by Great Britain—power is derived from the people. It is focussed, or concentrated, in the hands of the rulers who are to carry out the wishes of the people. In autocratic governments, represented by Germany, power flows down from the chief executive—the reigning family—to the people. Long years of tutelage so shaped German thought that the ruling class could think of no other foundation of government than brute force. This was the teaching of their great writer, Treitschke, whose philosophy captivated intellectual Germany. This conception of government was the rock on which the German Empire suffered shipwreck.

A NATIONAL IDEAL THAT LURED TO DESTRUCTION.

An ideal of national greatness founded on force took form and shape and became the great incentive to action. This ideal aimed at world conquest. In imagination the leaders in Germany saw a vast empire rising in Central Europe, extending from Hamburg to Bagdad, over which their kaiser should exercise despotic sway. This ideal was ardently supported by political leaders of all shades of opinion, and by intellectual Germany in general. It was to be won by peaceful means if possible, by the sword if necessary; and to secure its realization, every means that tended to such a result was employed. Educated Germany became obsessed with the thought that it was their high mission to extend their culture over the world, to subject all to their sway. Statesmen, writers, lecturers, military and naval officers openly and frankly voiced this national ideal.

DOWNFALL OF THE EMPIRE.

This attitude of mind shaped the activities of Germany after the peace of Paris in 1871 and could only end in world conquest or downfall. A detailed account of the principal events of the world war which terminated in the downfall of the empire is not necessary for our purposes. It only remains to speak of present conditions. The empire has ceased to exist. A republic has taken its place. The great colonial empire is lost. The work of Bismarck is completely undone. For twenty-five centuries Babylon ruled the ancient world, she forced her culture, her language, her laws and customs—even her religion—on the known world of her times. Babylon passed away. For twelve centuries Rome ruled the Mediterranean world. Evidence of her sway is still in existence from Scotland on the north to Mesopotamia on the south; from the Pillars of Hercules on the west to Constantinople on the east. Rome long since fell. Charlemagne united

in one empire the greater part of Europe. The empire fell in ruins at his death. Napoleon nearly reduced Europe to his rule. He died on St. Helena. Aspiring to world rule, Germany fell and must completely recast her national ideals if she is to regain the confidence and esteem of enlightened democracies of the world.

RUSSIA

The Russian Empire of yesterday, embracing in its vast area about one-sixth of the land surface of the globe, with a population estimated in 1912 at 171,059,900 is another instance of an autocratic government that has fallen in ruins, being one of the series of startling changes accompanying the great war of 1914. This result was not directly due to foreign conquest but to facilities afforded dissatisfied elements within Russia itself by reason of the government's participation in that war and consequent opportunity to engage in a successful revolt.

THE RUSSIAN EMPIRE.

It is necessary to gain a mental picture of the Russian Empire as it existed before the world war, in order to understand the Russia of today and the possible Russia of tomorrow. The empire extended from the Baltic Sea on the west to the Pacific on the east,—a distance of over 6,000 miles; from north to south it extended from within the Arctic Circle to the confines of Afghanistan —a distance of 2,300 miles. Its area was 8,764,586 square miles, but that includes the area of interior seas such as the Caspian. It will be noticed that this area was nearly three times that of Continental United States—the empire was the greatest continuous area ever brought under a single rule.

THE RUSSIAN PEOPLE.

In such a vast empire people of the most diverse ethnic stocks were found. The majority of the population—over one-half—belonged to the Slavonic branch of the Aryan race; but there were large numbers of Lithuanians, Finns, Tartars, Jews, Latins, Teutons and Mongols. Of this diverse population interest centers in the Slavonians, of whom there were in European Russia nearly 93,000,000 in 1912. This fact explains why Russia took such an interest in the fate of Serbia, also a Slavonic state, the ambition of Russia being to gather all Slavonic people under the flag of Russia. For some reason the Slavonic branch of the Aryan people has not developed as rapidly as other branches, such as the Germanic; and consequently the people of Russia, as a whole, were backward when compared with other European nations. This backward state of development explains much that was peculiar about Russia.

GOVERNMENT AND SOCIAL LIFE IN RUSSIA.

All races of the earth, without exception, were once living in a tribal state of society. Modern political society, as exemplified in the United States and Europe, is the third stage of development in the evolution of government. Back of this stage was tribal society. Into the details of that state of society we can not possibly venture. We must content ourselves with remarking that people in tribal society live in a different psychic world—a different thought atmosphere—than those who have advanced beyound that stage. In many ways we detect plain traces of this state of society still existing in Russia.

THE RUSSIAN MIR.

For administrative purposes, Russia was divided into various departments, and at the bottom, where was to be found the great mass of the people, was a condition many writers can not understand, because they never made a study of the development of government. It was the village system, the mir, as it was called in Russia. It was democracy in a pure form, the people themselves conducting their own local affairs and electing their own officers. These were the same liberties that the ancient Aryan people everywhere enjoyed—whether you are talking about the Greeks, the Romans, the Hindoos or ancient Germans—they all had the

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A RUSSIAN TROISKY—A MOSCOW CLUB.

same system. It is not meant that the customs were identical, but on the same general plan. This is only one instance that could be given illustrative of the peculiar state of affairs in Russia. A few decades ago the Czar by a stroke of his pen freed 50,000,000 serfs from bondage. But serfage was not peculiar to Russia. It often—almost generally—accompanied tribal development. England had the same experience 1,000 years ago, but the villeins freed themselves. The autocratic powers of the Czar and the ruling nobility generally, represented a stage of tribal development, traces of which still linger in most countries of Europe. The great struggle to institute constitutional government is the last stage of the conflict that puts an end to the lingering survivals of tribal society. It had long since been fought out in most of the countries of Europe. In Russia the struggle had been waging for decades. A notable advance had been won when the Czar instituted the Duma but it was a beginning, only; and in the struggle of the great war the old order of things was suddenly overturned.

RESOURCES OF RUSSIA.

Russia was pre-eminently an agricultural nation, but the methods used were primitive. In the last census year there were about 425,000 square miles under cultivation. All the principal crops of the temperate zone were raised and Russia often surpassed the United States in the production of wheat. The forest reserves of Russia were greater than those of any other nation, since they comprised about 875,000 square miles, an area far greater than that of all our country east of the Mississippi River. We do not know the immense totals of the forest reserve in Asia, but we do know that the crown forests, which formed only a part, were more than 1,000,000 square miles in extent. Here was timber wealth that ages could not exhaust.

In the Caspian Sea region are immense supplies of petroleum and naphtha. Over $11,000,000 worth of the latter was exported in the last census year of the empire. A fleet of steam and sailing vessels on the Caspian were engaged in the transportation of naphtha. Only the United States exceeded Russia in the production of petroleum. In the last census year of the empire 8,960,000 tons of petroleum were produced. It came from near the Caspian, but large supplies are known to exist in Eastern Siberia. There are over 20,000 miles of navigable rivers and 45,000 miles of railroad, and one of the wonders of railroad construction is the line across Siberia. To its great fairs, as at Nizhni-Novgorod, caravans laden with merchandise came from Central Asia. Manufacturing industry in Russia was great in the aggregate, but the real manufacturing age had not begun. Manufacturing was in the same stage as in England and other countries before the factory system was developed. It was peasant manufacturing in the multitudinous peasant villages of Russia, as in early days it was home manufacturing in England. This is an evidence of the backward state of development in Russia generally, to which we have referred.

THE DOWNFALL OF THE RUSSIAN EMPIRE.

Let it suffice to say that the difficulties confronting the Czar of Russia at the beginning of 1917 were such that it was almost impossible for him to continue in the world war. In addition, German propaganda had been very active. The imperial court was honeycombed by German intrigue. Under these circumstances, it was deemed an appropriate time for the dissatisfied elements in Russia to raise the banner of revolt. The Czar was compelled to abdicate in March, 1917. After some months of uncertainty as to his fate he was executed at Ekaterinoslav, Russia, in June of 1918.

COMPARISON WITH THE FRENCH REVOLUTION.

Like causes produce like effects and human nature is the same the world over and in all ages. A little more than a century earlier the world was startled by the explosive outbreak of the French Revolution. It was caused by centuries of misrule, a contemptuous indifference to the rights of the people, and to a failure to recognize that the old order of affairs was passing. The reign of terror that ensued forms one of the most tragic chapters in history. Only the fact that democratic civilization itself was engaged in a life and death struggle with autocracy, which struggle engaged the agonized attention of the world, prevented a general recognition of the fact that the scenes of the French Revolution, with all their attendant horrors, have been more than outdone in Russia. The dynasty of the Romanoffs has ended in death. The nobility of Russia have been sacrificed to the unreasoning fury of the Bolshevik rule, or, reduced to penury, they eke out a wretched existence. Thousands of her citizens have met death for no crime save that they belong to the bourgeois class. The empire has for the present fallen in ruins and it only remains to note some of the principal fragments permitting ourselves only a passing consideration of their immediate future.

RUSSIA IN EUROPE.

This includes that portion of the old empire situated in Europe proper. It possesses an area of 1,862,524 square miles having a population in 1910 of 160,095,500. It is impossible to determine its present population since famine, disease, internal disorder and the ravages of war exacted a heavy toll of human lives. Speaking generally, the surface of the country is one immense plain, gradually sloping to the north, south and west from Central Russia. Though there are a number of cities and large towns, the peculiarity of European Russia is the large number of small villages (a relic of tribal society) there being, on an average, a town or village to every four and seven-tenths square miles. Petrograd, the former capital, had a population of about two million. Moscow had a million and a half. There are seventeen other cities, each of which had a population of over 100,000. It will be noticed that European Russia, with an area two-thirds that of Continental United States, was far more densely settled than our country. It was a huge, compact country that needed only the blessings of education and free, orderly government to form one of the most prosperous countries of Europe.

FINLAND.

Disintegration early began in European Russia. Finland resumed its ancient independence. That country was formerly one of the grand duchies of Russia. It is located in the north west corner of European Russia. It has an area of 125,784 square miles. Nearly half as large as our state of

Texas, in 1909 it had a population of something over 3,000,000, thus considerably more densely settled than Texas. The chief industry is agriculture; its chief mineral output is iron. There are about 50,000 square miles of forest reserve. A glance at the map shows that Finland is in the same latitude as Alaska but in area is only some over one-fourth as large. It does not possess the abundant mineral and timber wealth of Alaska, but its climate is not as severe. Released from the tyranny of Russian rule, it will no doubt develop into a free, progressive nation.

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SCENE IN A SIBERIAN VILLAGE.

SIBERIA.

Siberia is the great northern plain of Asia. It formed a vast province of the Russian Empire. Its area is 4,786,730 square miles. That is nearly one million square miles larger than the area of the United States, including Alaska and our insular possessions. It is nearly half again as large as Brazil, or one-eighth larger than China. In days to come, Siberia will be one of the richest sections of the world. Development has barely begun. Only a small portion of its area is under cultivation, but the soil is fertile and all crops of the temperate zone can be raised in abundance. It has practically inexhaustible forest areas, an dmines of all valuable minerals. It is one of the great gold producing sections of the world, and over ninety per cent of the platinum of the world comes from mines in the Ural Mountains. At present the population per square mile is about two. With the introduction of modern agricultural methods, a vast population could be supported in Siberia.

CENTRAL ASIA.

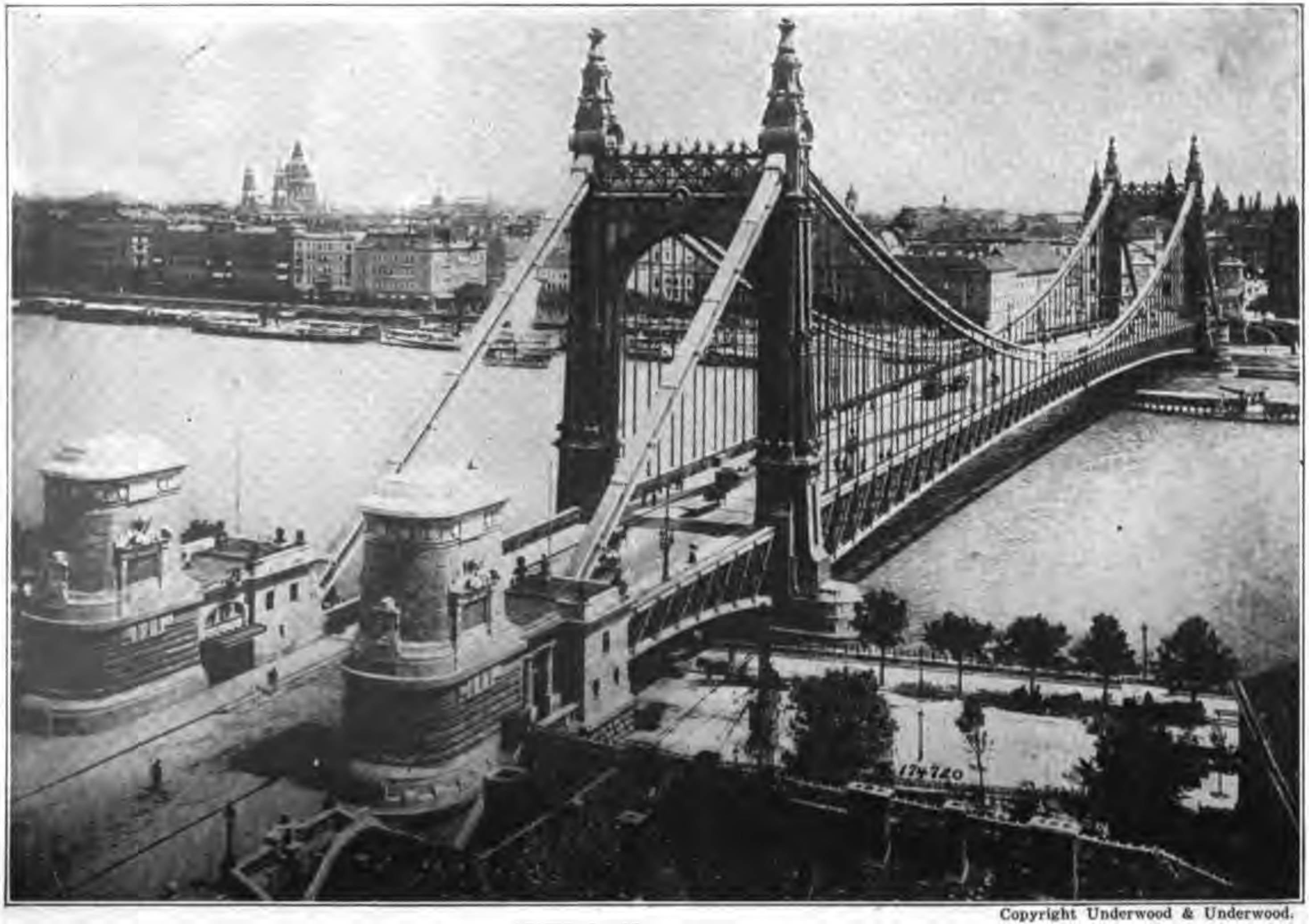
The provinces in Central Asia, including Turkestan, the trans-Caspian and the steppe provinces, have an area of 1,366,823 spuare miles. This is a grazing section, much of the territory is arid, some of it is classed as desert. Yet in early centuries, great populations were supported there and great streams of migrating people, like the Huns, descended from thence into the fertile provinces of Europe. At various places, fields of ruins, loosely covered by desert sand, attest the former existence of populous towns. This section possibly bears witness to the desiccating process that will in time render the greater portion of the earth a desert. However, it is possible that scientific irrigation and modern agriculture may improve much of that section.

AUSTRIA-HUNGARY

A map of Europe showing the geographical outlines of the nations as they existed prior to the world war shows the dual empire of Austria-Hungary interposing between Germany and the Balkan States. It also fronted Russia along an irregularly curved line, convex to the northeast, about 450 miles in extent, from Cracow to Czernowitz. On its southwest it possessed a coast line of about 400 miles on the Adriatic from Trieste to Cattaro. The total area of the dual empire was 261,035 square miles about equally divided between Austria and Hungary. The population in 1910, the last census year obtainable, was 57,314,271 of which about two-fifths belonged to Hungary. Previous to the war with Prussia (1866), Austria was the leading Germanic state. The dream of world conquest that shaped German diplomacy during the reign of Kaiser William II., could be realized only as Austria-Hungary became, to all intents and purposes, a vassal state of Germany. Events had been shaping themselves to that end for many years, and it was finally accomplished by a treaty between the two nations in 1918; but the total collapse of both nations followed in the fall of the same year, and the dual empire is of historic interest only. Austria has disintegrated and Hungary, shorn of large portions of territory, exists only as a minor republic.

NATURE OF THE EMPIRE.

We may describe the dual empire as being structurally very weak. The union between the two component parts of the empire—Austria and Hungary—was a very loose one. The main tie was that they had the same ruler,—the Emperor of Austria being



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GENERAL VIEW OF BUDAPEST.

Budapest is the capital of Hungary. Hungary is now an independent republic. The bridge is known as the Elizabeth Suspension bridge, named after the former empress Elizabeth of Austria-Hungary. It crosses the Danube River.

also the King of Hungary, he took separate oaths of office, and was crowned both at Vienna and Budapest. The two nations were independent of each other, though they had a common administration, for certain matters of state. In both nations the ruling classes—the Austrians (a German people) in Austria; and the Magyars (descendants of the Huns) in Hungary—were in the minority and each empire held in subjection other people of such diverse nationalities and so numerous that the dual empire was often spoken of as the Polyglot empire.

THE ETHNIC ELEMENTS IN THE DUAL EMPIRE.

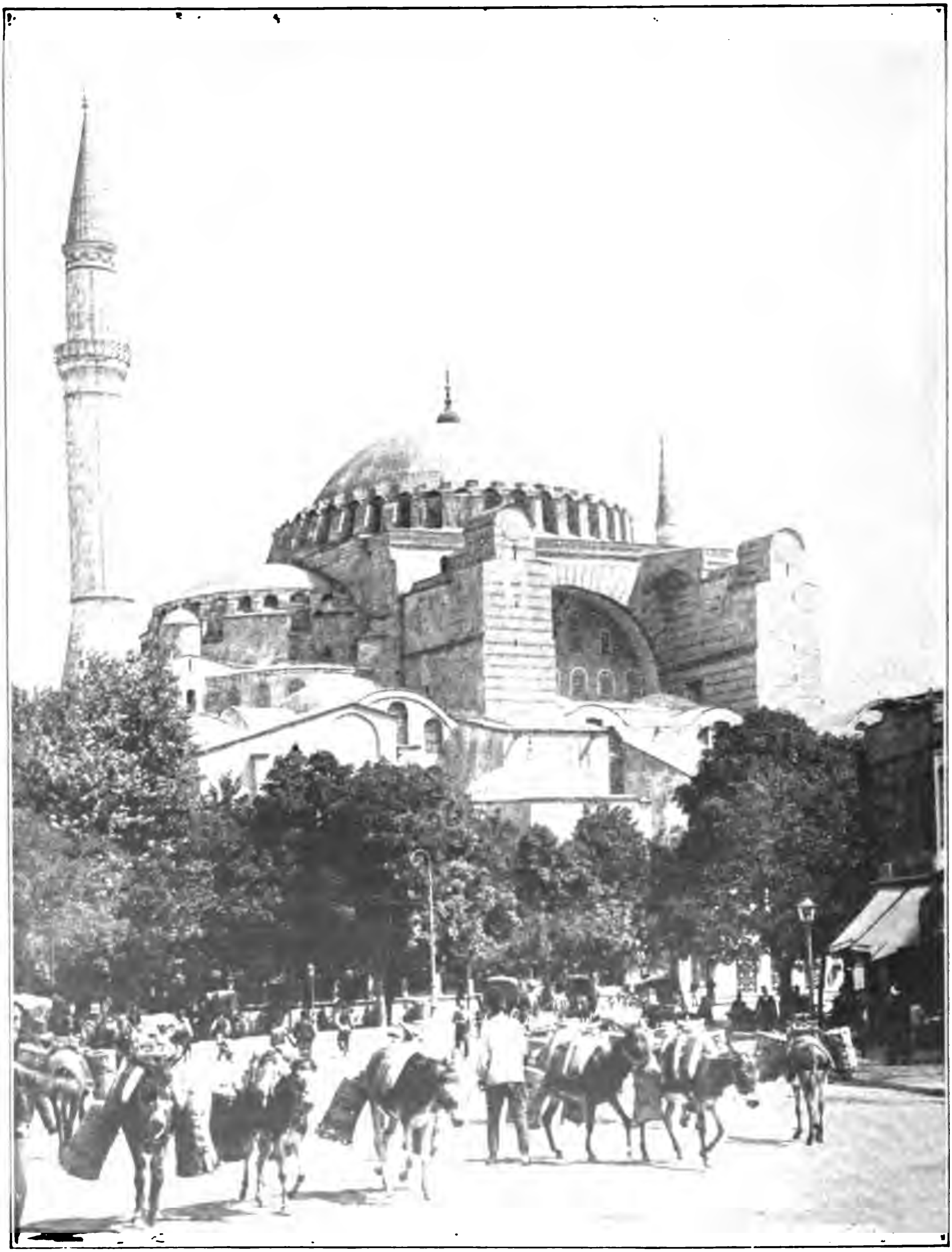
We need only to reflect over the following facts to understand the disappearance of Austria as an empire. There were about 10,000,000 Austrians (Germans) proper in Austria, but about 18,000,000 of subject people divided among no less than nine distinct nationalities, such as Bohemians, Moravians and Slovaks, in all 6,000,000 which now form a part of the new Czecho-Slovak republic. Then there were also Poles, Ruthenians, Slovenians, Serbians, Italians and Roumanians, about 12,000,000 in all. These (except the Italians and Roumanians) are united with the new nation of Jugo-Slavia or Greater Serbia. In Hungary about half the total population were of the Magyar (Hun) nationality, the rest were divided between the Roumanian, Slovaks and Croatians.

THE TURKISH EMPIRE

A map of the world showing the nations as they existed prior to the world war, discloses that Turkey included a small section of Europe, directly to the north of the Sea of Marmora, separated from Asia by the Dardanelles and Bosporus Straits, embracing an area of some over 11,000 square miles. But Turkey in Asia included a vast stretch of country almost 700,000 square miles in area, comprising all that part of Asia west of Caucasia in Asia and Persia, and an ill-defined fringe of Arabia bordering the upper part of the Persian Gulf and the Red Sea.

TURKEY DESCRIBED.

European Turkey and Asiatic Turkey north of a line drawn east of Alexandretta Bay were sections naturally fertile and rich in minerals. To the south of the line mentioned, the center part of the area rapidly passes into the desert section of Arabia; but on each side, somewhat like a gigantic V, opening to the south, there are two lines of territory of great historical interest, of great potential fertility. That to the east is Mesopotamia, the cradle land of early civilization. That on the west is Syria, including in its bounds the Promised Land of Biblical Story, also the lands held sacred by the Mohammedans including the cities of Medina and Mecca. All these lands have been cursed by centuries of misrule. There is not a sadder chapter in history than the story of Armenia, one of the mountain provinces of Turkey. In ancient times Mesopotamia was the seat of mighty empires. For twenty-five centuries Babylon was the Rome, the Paris, the London of the ancient world. All that is required is to set up a government of law and order, and clear out the old irrigation canals—among which were the



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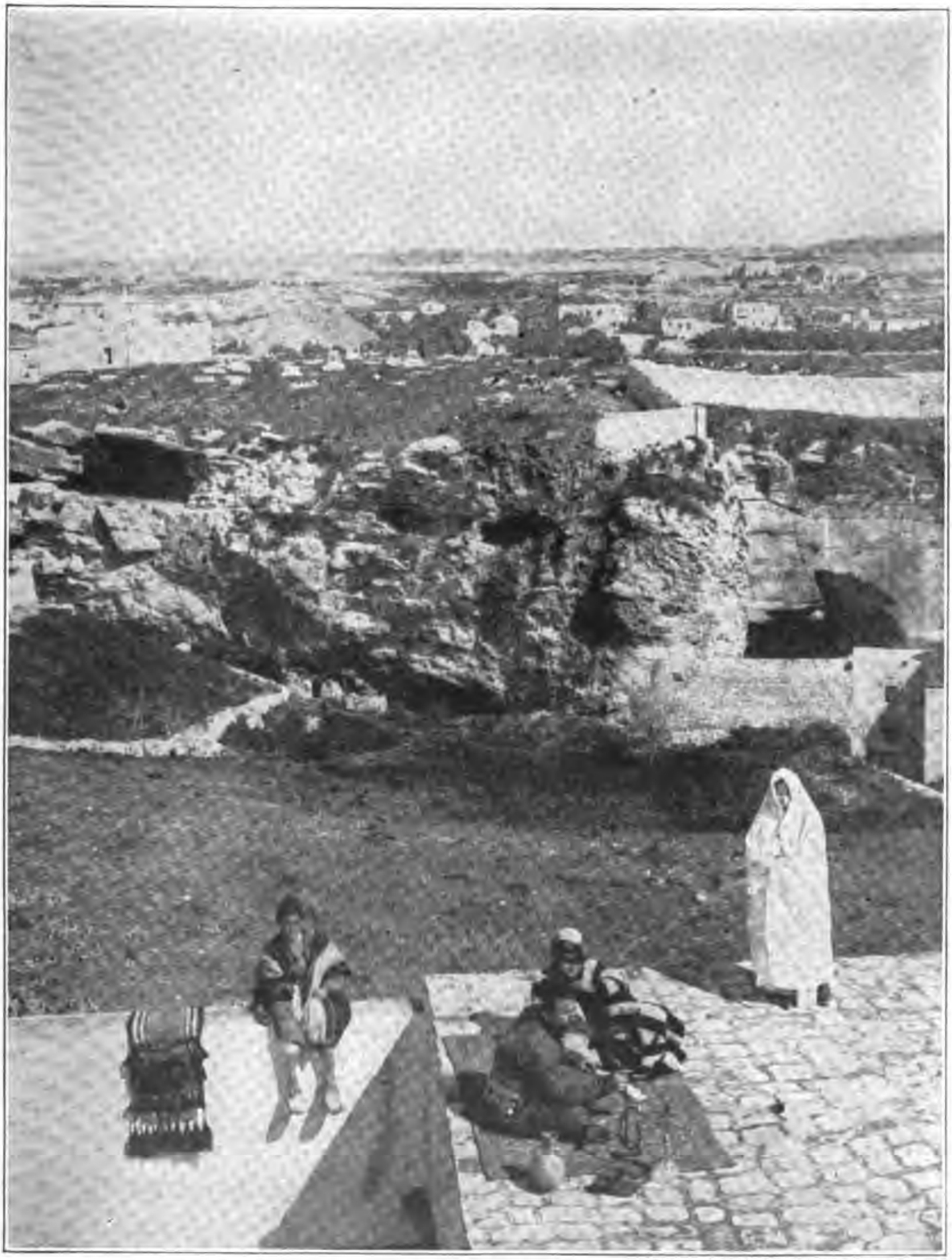
ST. SOPHIA IN CONSTANTINOPLE.

St. Sophia was a celebrated cathedral in Byzantum (Constantinople) in the days of the Eastern Empire of Rome. Except St. Peters in Rome it was the most celebrated cathedral of the Middle Ages. When the Turks captured Constantinople they turned it into a Mohammedan Mosque.



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JUST OUTSIDE OF JERUSALEM.

Jerusalem will doubtless be the capital city of a new Jewish Commonwealth. This view shows what is believed to be the location of Calvary (central in the view) outside the Damascus Gate, looking from the northern wall. Notice the resemblance of the elevation to a skull. (Matt. 27-33.)

rivers Gihon and Hiddekel of Genesis—to see that whole stretch of country become again a scene of smiling plenty. The western arm, including Palestine, was once so fertile that the Bible describes it as a land flowing with milk and honey. Over it all for weary centuries rested the blight of Turkish misrule.

STRATEGIC IMPORTANCE OF TURKEY.

It has been pointed out that Turkey in Asia occupies a section of country of singular strategic importance, so much so that in ancient times the power that possessed that country ruled the world. A glance at the map affords the explanation. A range of mountains guards the entire eastern frontier from the rest of Asia. On the north are the Black Sea, the Sea of Marmora, and the straits protecting it from attack from Europe, but in turn permitting its soldiers to venture forth for attack. To the west are the Aegean Sea with its numerous islands, inviting conquest; and the long Mediterranean shore line; a narrow isthmus connects it with Africa from which it is separated by the Red Sea. The great agricultural wealth of soil and mineral wealth more than sufficed for the needs of its inhabitants.

THE DOWNFALL OF TURKEY.

Shortly after the World War opened, Turkey became an ally of Germany, and met the fate of all the Teutonic allied nations—complete defeat. It only remains to point out certain great changes that followed. Turkey no longer retains rule over any non-Turkish people. An Arabian kingdom has been established but its limits are ill defined. One of the happiest results is the liberation of Palestine. The fondly cherished hopes of a large section of the Jewish people—hopes entertained ever since the days of the Roman conquest—are fulfilled; a Jewish commonwealth once more is established in Palestine. What a theme for reflection. Once more the City of David is free. That for which the Crusaders fought is now an accomplished fact. Granted the blessings of free and liberal government, with an educated citizenship, why may we not expect Palestine to become once more a land of milk and honey—symbolical of material prosperity—and that the whole earth will be blessed in her prosperity?

And the sunrise of a new day is also breaking over the plains of Mesopotamia, that section of marvelous fertility. Here are the plains of Shinar, the sites of cities old before the days when Abraham went forth from Ur of the Chaldeans. Great fields of ruins still attest the former greatness of Nineveh and Babylon. Now that the heavy hand of Trukish rule is lifted from off this land of ancient story we may expect to see smiling fields and thriving cities afford evidence that a new cycle has begun in Mesopotamia of old.

THE KINGDOM OF ITALY

Italy in Europe occupies the entire Italian Peninsula and flares out, so to speak, at the head of the peninsula in Europe. The important islands of Sardinia and Sicily together with some smaller islands off the coast also belong to Italy. Previous to the World War the area of Italy in Europe was 110,659 square miles. That area is now increased by considerable accessions of former Austrian territory at the head of the Adriatic Sea, including all of "Italia Irridentia" (Unredeemed Italy), that is, territory formerly Italian taken from Italy by force in former wars with Austria, restored to Italy as a result of the World War and downfall of Austria.

ITALY'S POSSESSIONS IN AFRICA.

Italy possesses a colonial empire in Africa far larger than the home empire in Europe, being in area 584,130 square miles. Thus we see that Italy takes her place with France and Great Britain as one of the world states. The most important province of the Italian African possessions is Tripoli, in area nearly 400,000 square miles. It forms one of the north central coast provinces of Africa, adjoining French territory on the west. That province is now in a backward, undeveloped state. It has only been an Italian possession since 1912. In Roman days, Tripoli was a fertile, prosperous section of the empire. There is no reason to doubt that under Italian rule it will again experience a time of prosperity. The other Italian possessions in Africa are not important, at least at present. They are narrow strips of coast territory,—one, fronting the Red Sea, is known as Eritrea; the other, Italian Somaliland, occupies the central tip of Africa, on the eastern coast between the equator and latitude twelve north. In days to come these may both be valued possessions.

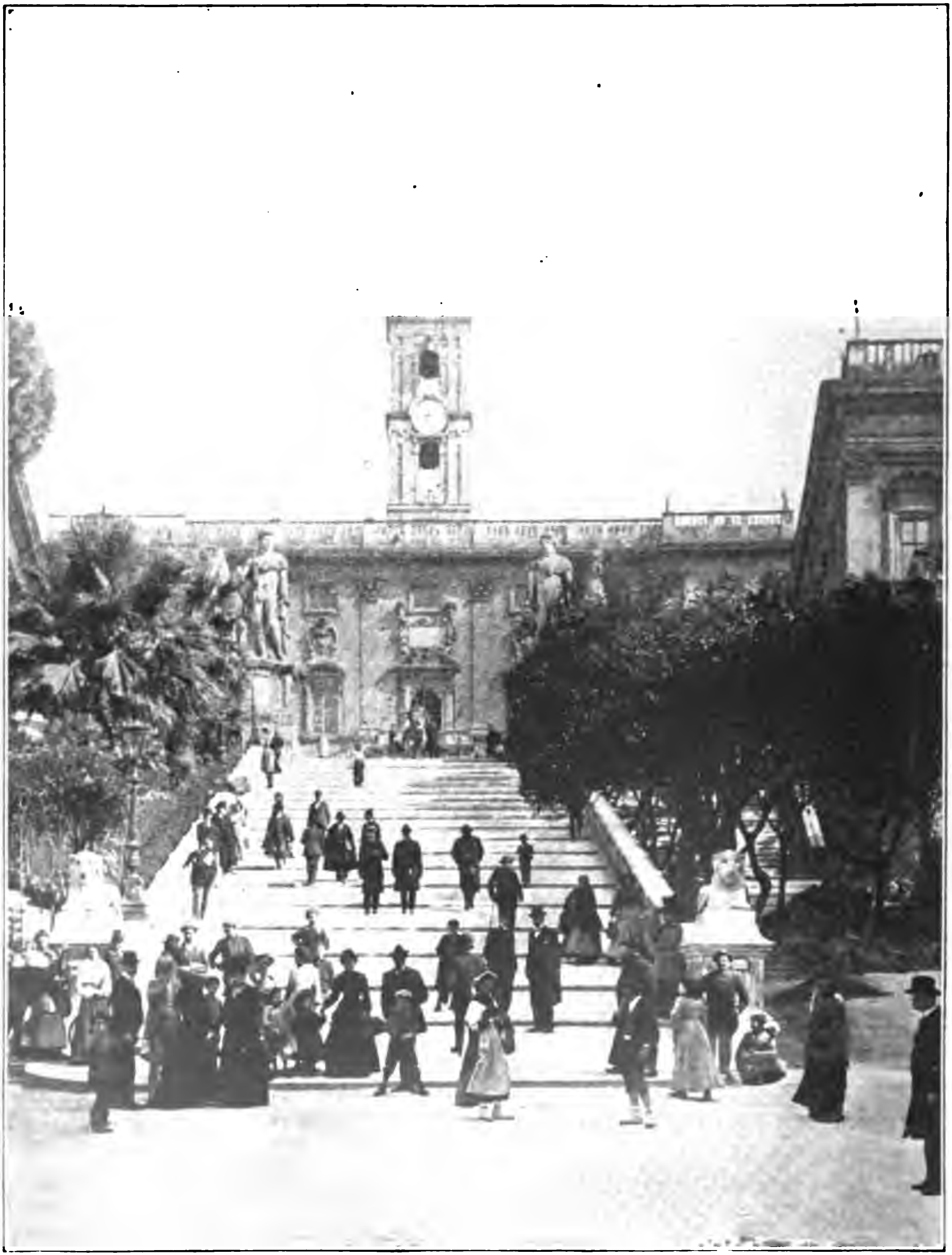
SAN MARINO.

Since 1862 San Marino, the smallest republic in the world, has been under the protection of Italy, though it is an independent country, one with which the United States has a treaty. It is located in the hills about ten miles from Rimini, Italy. It is only 38 miles in area. Its capital, San Marino, is still surrounded by a fortified wall. It issued a declaration of war against Austria in the world war. This was necessary because her soldiers were fighting in the Italian army. We can only surmise that in ancient times, San Marino was the home of a small but independent tribe around whose small borders the waves of modern times passed but did not engulf it. And so for 1,500 years the people were left in the enjoyment of their independence. They voluntarily placed themselves under the protection of Italy.

ITALIAN HISTORY.

Italian history is of great interest. That peninsula was the heart of the Roman Empire, the law giver of antiquity, whose code of laws still sways the courts of all Latin countries and is the foundation of jurisprudence in one state of our union. For a thousand years Rome was the principal city of the world. Mournful ruins of Imperial Rome yet attract the traveler. There is the Appian Way, trod by apostles and martyrs; there are dilapidated arches, commemorative of Roman triumphs nearly two thousand years ago; there is buried Pompeii, in whose resurrected streets we can study the home life of a Roman city in the first century of our era. There are ruined theaters, baths and arenas, bespeaking the pampered luxury of the imperial city. All of this should impress us with a sense of the fleeting nature of human greatness.

After the fall of the Western Empire of Rome, the city of Rome remained the spiritual capital of Christendom. Neither must we forget the glorious days of the Italian City Republics when the Doge of Venice went forth in panoplied pomp to wed the Adriatic, a ceremony symbolical of the



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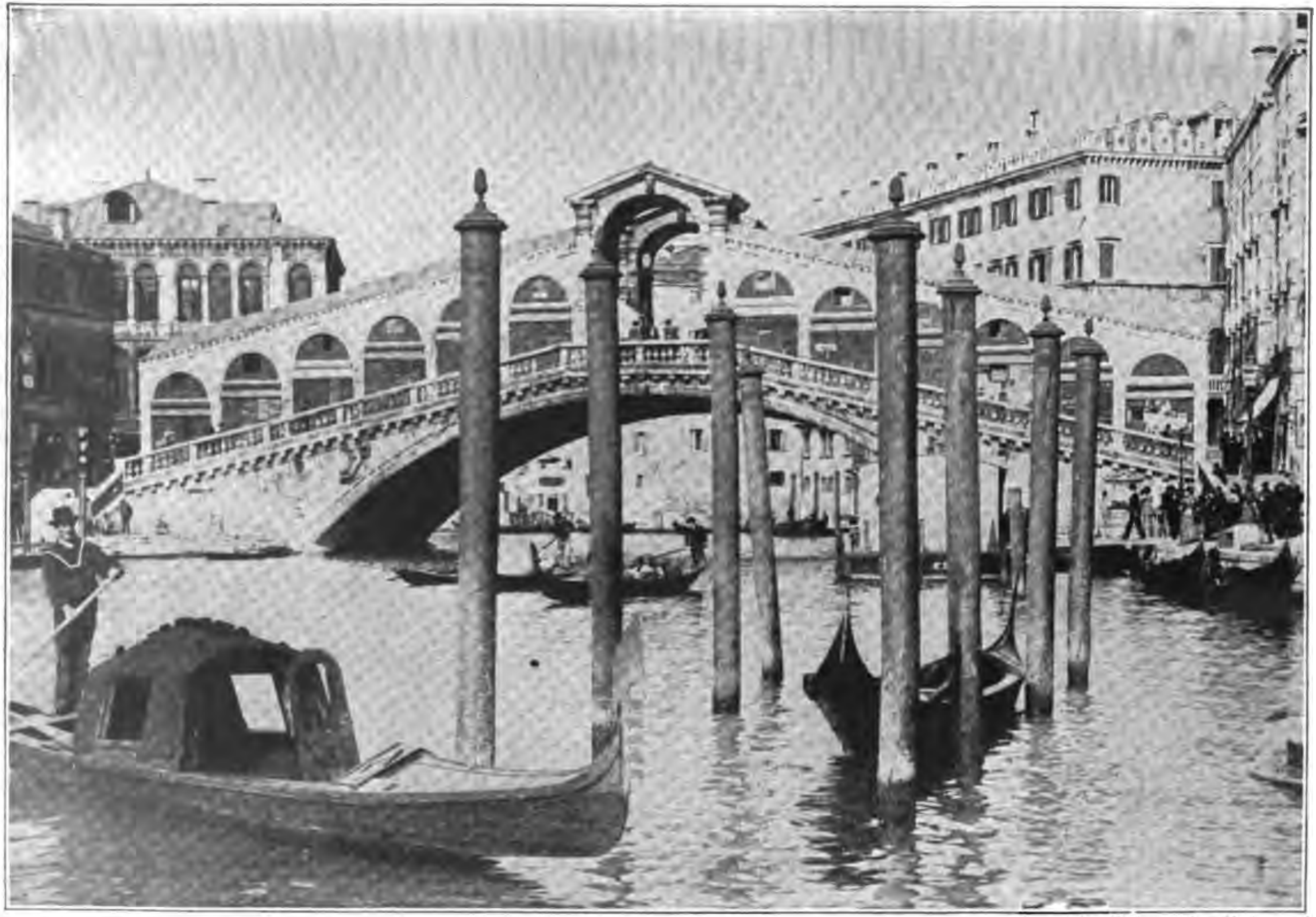
THE PALACE OF THE SENATORS. ROME.

This building, still in good preservation, occupies the site of the ancient Labarum on the Capitoline Hill, in Rome. It is the center of the side toward the Forum. Notice the broad stairways leading up the hill. It is one of the most impressive spots in Rome.



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VENICE AND ITS CANALS.

The Grand Canal, shown in this illustration, dominates Venice, winding through the city like an immense letter S, other canals, like intersecting streets, lead into it. The bridge is the Rialto. The supporting arch is 74 feet in length, 32 feet in height. Two rows of shops divide the bridge into a broad central road and two narrow side passages.

maratime and commercial supremacy of Venice. Finally the world will ever remember that great Genoese navigator, Columbus, who braved the unknown terrors of the Atlantic, and discovered a new world.

UNITED ITALY.

The present kingdom of Italy is of modern origin. It was to the interests of Austria and the Holy Alliance (including virtually all the nations of Europe) to prevent the union in one state of the many petty states of Italy in the first half of the 19th century. Among these states must be reckoned the states of the Church wherein the Bishop of Rome, head of the Catholic church, exercised the powers of an autocratic ruler. It was not until 1861, under the leadership of Garibaldi, that the most of Italy became united under the rule of Victor Emanuel. Not until 1870 did the church cease to exercise kingly rule and modern Italy came into being. It will be noticed that year was also the date of the formation of the German Empire that, as an empire, has now ceased to exist; but United Italy emerged from the war with greatly increased prestige, with increased territory, and faces a reassuring future. Again we will notice how the World War sounded the knell of autocratic governments—those engaged on both sides of the conflict—Germany, Russia, Austria-Hungary and Turkey; but strengthened democratic governments—Great Britain, France, and Italy. Can we not read in this the lesson that a Power greater than that of Czar or Kaiser guides the evolution of nations?

POPULATION AND INDUSTRY.

The latest available returns show the population of Italy as 35,238,957. It will be noticed that in spite of heavy emigration Italy is still far more densely settled per square mile than the United States. Agriculture is the chief industry. Seventy per cent of its total area is productive and one-third of the entire population is engaged in agriculture. All the crops of the temperate zone are raised and in addition immense vineyards and olive groves are in existence, yielding respectively more than a billion gallons of wine and oil annually. Semi-tropical fruits—oranges, lemons and figs—are grown in the south of Italy. Unless we stop to think about it, we fail to realize that this favored land is due east of Northern United States.

MINERAL WEALTH.

It will be noticed that much of Italy is mountainous. The peninsula itself is due to the long range of the upheaved Appenines, while to the north, in the bulging head of the peninsula, are the flanks and outlying spurs of the towering Alps. Naturally in such a country we look for mineral wealth. All of the principal minerals are found, not in abundance but in quantities profitable for mining purposes. The principal mineral, however, is sulphur. There are over 400 sulphur mines. Sulphur is a valuable product; it was doubly so during the World War. It is interesting to remark that deposits of sulphur always imply the near presence of volcanic activity, though all traces of that activity may have disappeared. In Italy the most abundant sulphur deposits occur in the vicinity of the still active volcanoes—Vesuvius and Etna. Another product, present only in mountainous sections, is marble, and Italian marble is famous the world over.

THE GOVERNMENT OF ITALY.

The government of Italy is that of a limited monarchy, not as liberal as that of Great Britain, but the powers of the King are strictly defined. The constitution provides that no official act shall be valid unless countersigned by a minister, and the ministers are responsible to parliament, so that the policy of the government is shaped by the people, not by the ruling house. The parliament consists of two houses—the Senate and the House of Deputies. The Senate is like the House of Lords in England. It consists of princes of the royal blood and life members appointed by the king. The members of the House of Deputies are elected by the votes of male citizens above the age of twenty-one.

SUMMARY.

We have now briefly considered the Kingdom of Italy, a recent comer in the family of nations though its roots sink deep into the past. It has fairly earned its position among the great nations of the world. In the world war it took its place among the nations fighting for liberty. Its armies most worthily upheld the honor of their country. The conclusion of the war left it a firmly united country, taking its place among the leading nations of the world banded together to secure enduring peace.

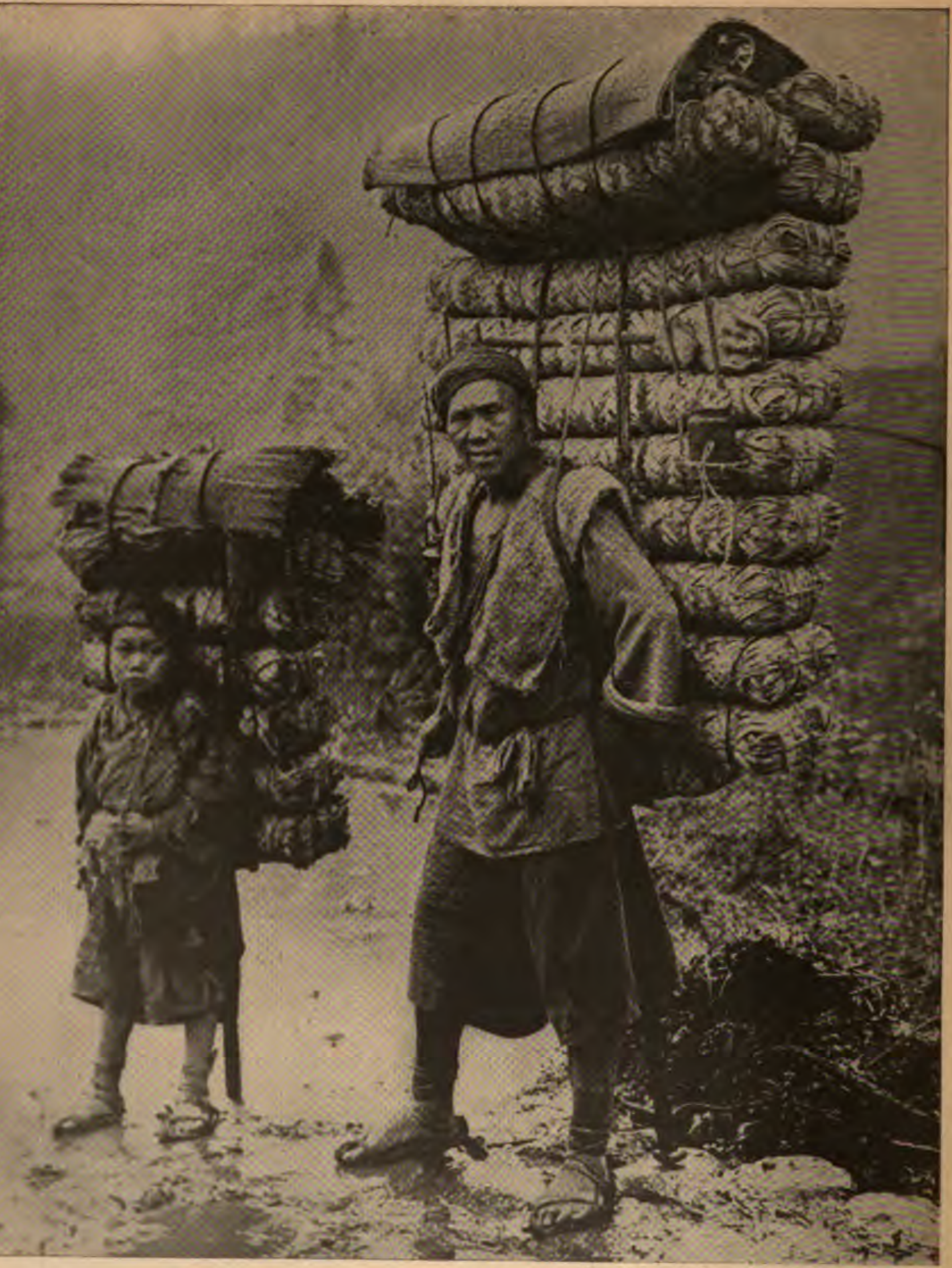
CHINA

China is not only our antipodes, geographically speaking, but in many of its manners and customs. It is a land where old men play with kites while boys stand sedately around, a land where white is the emblem of mourning, where if an official is ennobled his ancestors at once are honored but his posterity does not share in his privileges; a land where the people instead of being alert, eager to advance and change their way of living, are looking ever to the past and their one great care is to hold steadily to the manners and customs and ways of living that their ancestors enjoyed. It is a land of a wonderful past as it was a civilized country at the very dawn of history, long before Europe had caught the light radiating from the valleys of the Euphrates and the Nile, and it has seen strange mutations in its history. The curtain only lifts now and then affording a passing glimpse of its people. But the dawn of a new age is at hand and thoughtful students believe that a new cycle in history is about to begin in China of old and that once again she is to fill a position of imporportance in the affairs of the world.

China is now the largest republic in the world; its total area being 4,277,170 square miles. That is a territory as large as the United States, Alaska and Mexico combined. From north to south, the republic extends 3,000 miles, from east to west 2,400.

POPULATION.

The population of China can not be given with exactness, but the best attainable results are from the census of 1910. The total population of China and its dependencies (including Tibet generally omitted) is, according to that census, 336,000,000. Other authorities give results differing materially from these, generally larger. China proper has a population of some over 304,000,000,



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CHINESE TEA CARRIERS.

The little 12-year-old boy is carrying 80 pounds on his back. His father has 350 pounds. They will walk 400 miles, cross two mountain ranges, with passes 10,000 feet high, and make the trip in twenty days.

that means that in an area less than half the United States, is a population considerably more than three times as great in the same census year.

There are many very large cities in China of which the outside world knows almost nothing. Pekin, the capital, is a city of about 1,200,000 inhabitants. There are six other cities of about 1,000,000 each, and as many more of half a million each. In general, our stock of information in regard to the resources and possibilities of China is extremely deficient. The same is true of what passes for history of China, even the native histories are utterly unreliable.

EXAMINATION HALL AT CANTON.

Formerly all official advance in China depended upon proficiency in tenets of Confucianism.

THE PEOPLE.

The people of China are of great interest to all students, and unless we understand something of the psychic world in which they live, we can not understand the role which they have played. They are members of the Yellow races. Without going into the niceties of the question, there are three great groups of races in the world—the black, the yellow and the white. Each of these races has its distinguishing mental and physical peculiarities. It is difficult for the average European or American to understand the psychic world in which the Chinese, Japanese or other members of the Yellow race live and move and think and act. Each of these groups of races has enacted a distinct part in the work of advancing man from savagism to civilization. The Yellow races had an important part in developing early civilization; into the details of this work we cannot enter. When the White Races, everywhere following the Yellow Races, appeared on the scene, heirs to all that had preceded them, they took the lead in the new era, the era of civilization, and the Yellow Races remained in an almost stationary stage of culture. The truth of this is shown in the history of China and Japan. We have seen Japan rousing to modern life within the last fifty years; China is but just waking. When fully aroused there is no question of the influential role the nation is destined to play in Asia, perhaps as important as that of their distant progenitors long before the dawn of authentic history.

Much that seems strange in China is due to their, as yet relatively, undeveloped state. Plain traces of tribal society are visible in the social life of the people. Feverish attempts are being made by the educated, upper stratum of Chinese people to assume the habits of thought and realize the political life of the more advanced nations. Surprising progress has been made in all these matters. The world was electrified when the republic was proclaimed. Grave doubts have been expressed as to is permanence, and unquestionably it is far in advance of the majority of the people, but we need not be surprised at anything in China, remembering the achievements of the Yellow Races in earlier ages. The organization of tribal society, under which mankind achieved civilization, was their work.

RICE CULTIVATION IN CHINA.

CONFUCIANISM.

Confucianism is not, properly speaking, a system of religion, but it is an ethical code of practice which has long held an honored position in China. For centuries it dominated the social, moral and political life of the people and moulded their character. All religions are naturally conservative, but Confucianism is pre-eminently so. All its ideals of life are those of ancient times, consequently the Chinese people became the most conservative in the world. They wanted no change. Education consisted in understanding the teachings of Confucius. All advance in official life was conditioned on the results of examination, not in science or government, but in the tenets of Confucius.

MODERN EDUCATION IN CHINA.

All this has been changed. The scenes at the great examination hall at Canton were abolished in 1905. Since then, modern learning is replacing Confucianism as the basis of education. Great advance has resulted. At Pekin is a government institution where all modern languages are taught, and modern science as well. At Tientsin there are a Chinese University, an Anglo-Chinese College, an industrial school under Japanese instructors, and a modern medical college, and in the provinces are ten other higher schools with 1,900 students and seventy-eight teachers. In fifteen provincial capitals, colleges have been founded, while primary and secondary schools, mechanical, agricultural and military, are springing up all over China. In Wuchau, sixty government schools have recently been opened. It is estimated that altogether some 36,000 educational institutions of all grades are now to be found in China. In 1905, in the province of Chihli, there were only about 8,000 students. In 1911 in the same province 250,000 were in attendance. There were in that province two high normal schools, forty-nine elementary normal schols, two medical colleges, three language schools, eight commercial college, five agricultural schools, thirty middle schools, 174 upper primary schools, 8,534 lower primary schools.

All this shows what a splendid start has been made. It is going to take a long time to overcome the inertia of ages. The great mass of the people are still very backward and in essentially tribal conditions, but the change is impending; it is coming fast, and bearing in mind the past achievements of the Yellow Races, the western world will soon realize that it has to meet in the area of the world's activities, a vigorous, resourceful, and puisant people, constituting the new Republic of China.

AGRICULTURE IN CHINA.

The greater part of the native population is engaged in agricultural pursuits. The land is well distributed; ten acres is considered a good sized farm and every available foot is utilized. Such is the conservatism of the people, however, that the most primitive methods of cultivation are followed. Irrigating ditches run everywhere through the farming districts, fed from abundant supplies of water from the mountain slope. Tea, cotton, cereals, sugar and indigo are the chief products. Rice is raised in enormous quantities. Oranges, pineapples, bananas and other fruits are grown in the south, while apples, grapes, and peaches flourish in the north. About 200,000,000 pounds of tea are exported annually, and cotton is rapidly becoming a valuable article of export in North China. The republic is the greatest poultry raising country in the world, and eggs are imported into our country from China to supply the California markets. About one-fourth the world's supply of silk comes from China. On an average over $60,000,000 worth of silk, raw and manufactured, is exported yearly.

MINING IN CHINA.

Many of the provinces of China proper and the three provinces of Manchuria contain coal, and China may be regarded as one of the great coal nations of the world. The estimated coal areas are over 250,000 square miles. In Shan-si there are over 13,000 square miles of anthracite coal deposits, said to be as fine as the anthracite from Pennsylvania. In the last census year the yield of coal in Manchuria was 1,200,000 tons. This is not bad from a country where only a few years ago mining was forbidden, because it would disturb the great earth dragon and so cause earthquakes. Copper, lead, quicksilver, tin, zinc, antimony, gold and silver are all to be found. In Shan-si, just where anthracite is so abundant, iron ore is also abundant. Copper ore is plentiful in Yuman.

CHINESE MERCHANT AND HIS ASSISTANT.

INTERNAL COMMUNICATION.

China is traversed in all directions by roads, the majority poorly kept, but it has also a great many canals. The Great Canal of China is worthy of special mention. It is between 800 and 1,000 miles in length. It extends from near Pekin to the coast province of Chekiang, on the China Sea. While making use of existing rivers and lakes, this canal represents a great construction work, part of which is said to date from the time of Confucius. In places it is more than one hundred feet wide, spanned by fine stone bridges, with its banks faced with stone. Smaller canals, some of them very ancient, ramify the entire country. All of this constitutes a canal system more than five thousand miles in length which has proved of the greatest benefit to China.

Railroad development is just beginning in China and undoubtedly in the not distant future that country will witness an enormous increase of railroads. They will be needed to accommodate the great trades of China sure to be developed in the near future. There are at present about 1,500 miles in operation.

FOREIGN TRADE.

Though recent years have been seasons of great confusion in China, yet the total foreign trade movement amounts to about $600,000,000 a year. This is regarded by all students as only a beginning. It is thought that in the future, when China shall have become thoroughly awake to modern learning, it will become a great manufacturing

CHINESE LAPIDARY, OR STONE CUTTER.

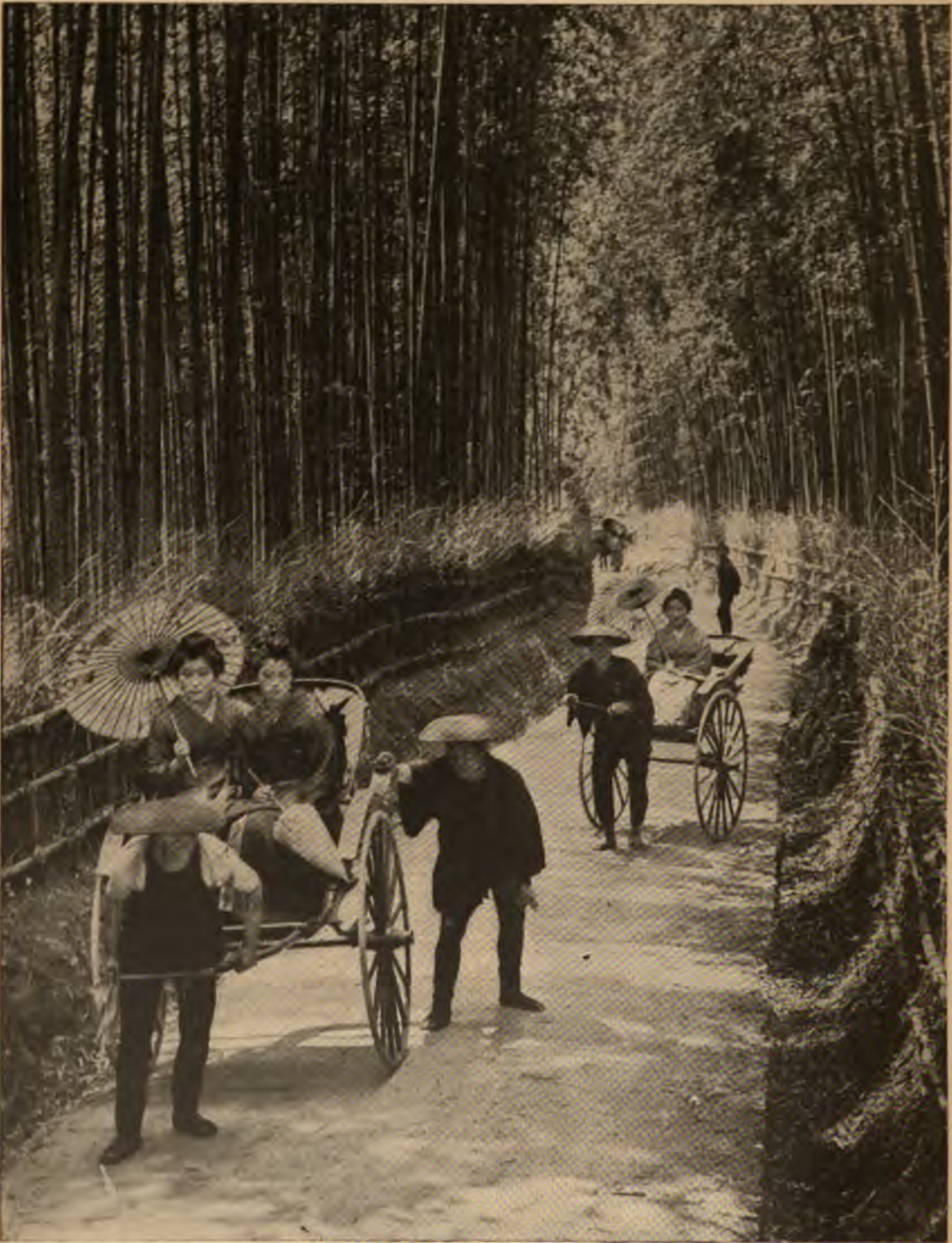
THE PRIVATE SEDAN CHAIR—CHINA.

nation, having a great deal to sell to other nations, but as its people become better able to buy, they will need vast supplies from the outside, and it is thought that in the future great commerce of the Pacific, a great deal of it will come from China.

JAPAN

Japan is surely one of the most interesting and remarkable countries in the world. Relative to the continent of Asia, Japan occupies a position strikingly similar to that of the United Kingdom of Great Britain to Europe. Both are insular possessions, separated from the mainland by narrow seas. Both are the centers, the hearts, of powerful empires. Great Britain has brought under her political control vast sections of the world, but she has had centuries in which to accomplish that result. Japan has been a world power less than a quarter of a century, but already she possesses 84,031 square miles in Korea, on the continent, has acquired control of the important Lia Tong Peninsula, with its great harbor of Port Arthur, Formosa Island, and the southern half of Sakhalin, a total area of over 110,000 square miles. Besides that, Japan now exercises a predominant influence in Manchuria, a most fertile province of China of 363,600 square miles.

Manchuria is still nominally a part of China, but Japan and Russia have it under their control, and Japan has the greater share of power. By a treaty which Japan forced upon China in the spring of 1915, the vast republic itself comes dangerously near being a dependency of Japan. Having accomplished all this in a brief quarter of a century, it is unsafe to set limits to future achievements, for it is the known determination of Japan to exercise the hegemony of the Yellow Races, and what power is there to stay her hand? United, the powers of Europe might do it, but Japan has chosen the time when they are engaged in



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JINRIKSHA TRAVEL IN JAPAN—BAMBOO FORESTS ON EACH SIDE.

mutual destruction to make her opening moves.

DEVELOPMENT OF JAPAN.

The story of the rapid development of Japan from a medieval island empire in 1853, excluding herself from communication with the outside world, a state of no international importance not yet evolved from tribal society, with a two-headed government, which is the inevitable accompaniment of tribal society evolution, to the world power of the opening years of the twentieth century after humbling China, forcing Russia to agree to her terms, victorious on sea and land, constitutes a chapter in history which has no parallel. We are now confronted with a powerful nation, organized for government on the most advanced lines, following in that respect Germany. The people are poor, but education is general and compulsory. The last school census showed an attendance at the three universities where the most advanced courses were being taught, of 8,000 students, while nearly 7,000,000 children were attending the elementary and special schools of the empire.

AREA OF JAPAN.

The island empire of Japan, or Nippon, consists of six large islands and numerous smaller ones, off the eastern shore of China, from which it is separated by the Sea of Japan. The area of these islands is 147,353 miles, the population is almost 50,000,000. It will be noticed that the total area is considerably less than the area of California, but the population of California in the last census was 2,378,000. Thus we see that Japan is densely populated, the population per square mile exceeding 335. It is such a fact as this, coupled with the ambitions, virile and warlike character of the people, that is forcing Japan to gain political control of other sections, where her population can find means of subsistence. It is this which is sending her into Manchuria, where the population is less than fifty to the square mile; and this compelled her to acquire Korea, Formosa and part of Sakhalin. Even with these additions, however, the total area of Japan is less than our state of Texas, though its total population is about half that of the United States.

RESOURCES.

About half the population is engaged in agriculture. Examining the statistics of the last census, we note that all of the principal crops of the United States except corn are raised, and in addition tea is a very important crop, over 67,000,000 pounds being reported. Rice is the principal crop, and the main food of the people, nearly 238,000,000 bushels being raised. As showing the poverty of the great mass of the people, the small farmers comprising by far the greater number of people engaged in farming can with difficulty make more than five cents a day; that is less than $20.00 a year. Yet the people of Japan are burdened with a national debt exceeding that of the United States.

MANUFACTURES.

In such a large population, a large number of people must subsist by manufacturing. A great many cotton mills are running, and cotton is the principal article of export from the United States to Japan, amounting to nearly $100,000,000 worth annually. One fact should be noticed in regard to manufacturing in Japan. We noticed the same phenomena in Russia. Manufacturing has not yet reached the factory stage—that is, for most industries. While 88,325 people were working in the cotton factories of Japan in the last census year, 486,936 families were weaving cotton and silk fabrics in their homes. Raw silk and articles of silk manufacture constitute the principal articles of export. In general terms, the total foreign trade movement in any country is a gauge of the development of the people; it indicates vigor of circulation of that on which civilization depends, trade and commerce. It is therefore interesting to note that Japan with less than one-sixth the population of China proper, and only one-tenth the area, has a total of exports and imports not very much below China herself. As China advances, this condition will not continue.

THE FUTURE OF JAPAN.

Having accomplished so much within recent decades, in every department of national growth, it is not at all probable that Japan has reached her zenith of power and influence. Only vigorous action and instant steps in modern development, perhaps accompanied by outside pressure, will prevent Japan from gaining more ascendancy over China. In any event, she will monopolize more and more of the trade of China. Should she gain her ambitious plans, hegemony of the Yellow Races, she will be a world power of the very first magnitude. She is making every effort to gain the ascendancy in the Pacific—the ocean of the future—and she may succeed. At any rate, she will stop at no means within her power to gain her ends.

NATIVES OF CEYLON—SEARCHING FOR PEARLS.

QUESTIONS ON GREAT NATIONS

What direction from you is the geographical center of the United States?

What republics surpass the United States in area?

What is the area of your State?

Was your State ever a territory?

How did it become a part of the United States?

Supposing your State was as densely settled as Rhode Island, what would be its population?

In what direction from you is the center of population?

Mention some interesting facts about our national wealth.

What is our greatest single source of wealth?

How does the commerce of the "Soo" Canal compare with that of the Suez Canal?

How does our inland commerce compare with that of other nations?

What is the combined area of our outlying possessions?

What is the area of Alaska?

What do you think is the greatest industry of Alaska in real value?

What countries in Europe are due east of Alaska?

Mention some items of interest about seals in Alaska.

What is the area of Hawaii?

What great natural curiosity in Hawaii?

Have we any other volcanoes in United States territory?

Any in any of our States?

Where is Guam?

Mention items of interest about the Philippines.

The Philippines and Porto Rico differ in their relations to the United States. How?

Where is Samoa?

What is the latest acquired possession of the United States?

What renders that acquisition valuable to us?

Considering all our outlying possessions, what ones come to us by purchase?

What event disclosed the resourcefulness of the United States?

What is a cantonment?

Mention items concerning the magnitude of our cantonment building.

Where is the largest ship building plant in the world?

What is sea power?

How did we triumph in aircraft production?

What invention assisted in that work?

Where is the largest office building in the world?

In what way did our country solve the food problem?

Mention our chemical triumph.

Mention some of our sources of potash.

Give facts concerning our financial strength?

Mention items of interest concerning the Yellowstone Park.

What are geysers?

After reading the description of the Yellowstone Park, give an outline of past geological times.

What and where are petrified forests?

What is the explanation of their formation?

What was the origin of canons?

Mention items of interest about the Grand Canon of the Colorado.

Describe the Yosemite Valley.

Mention other sections of great scenic beauty in the West.

Describe the great trees of California.

How does Niagara compare with other

noted falls in the West? With the Yellowstone? With the Yosemite?

Mention items of interest about Florida.

What and where is Latin America?

How many separate nations does it include? How many in Central America? How many island republics?

Which one is the largest?

Which one, think you, has the most promising future?

What is the official language of the largest one?

What is the language of the most?

Is French spoken in any?

What one is in special relation to the United States?

In what one is coffee raised?

What one produces tin?

What one is noted for its wheat?

Describe the Amazon River system.

There are two very important cities in South America. Compare them.

What is the area of the British Empire?

What has been the effect of the World War on that Empire?

What is included in the term "The United Kingdom"?

What is its area?

Give items of interest about its shipping and commerce.

What is meant by "the Dominion of Canada"?

How does it ocmpare in area with the United States?

How many provinces in Canada?

What are the principal industries?

What can you say about agriculture in Canada?

What is meant by Australasia?

What is the great industry of Australia?

What is the area of India?

Mention the great rivers of India?

Describe the government of India?

What is the Taj Mahal?

Where is cinnamon raised?

What is the most northern possession of Great Britain in Africa? What is its area? Mention items of interest about its past history?

What great irrigation work is to be found?

Describe Great Britain's South African possessions?

How do the Zambesi Falls compare with Niagara?

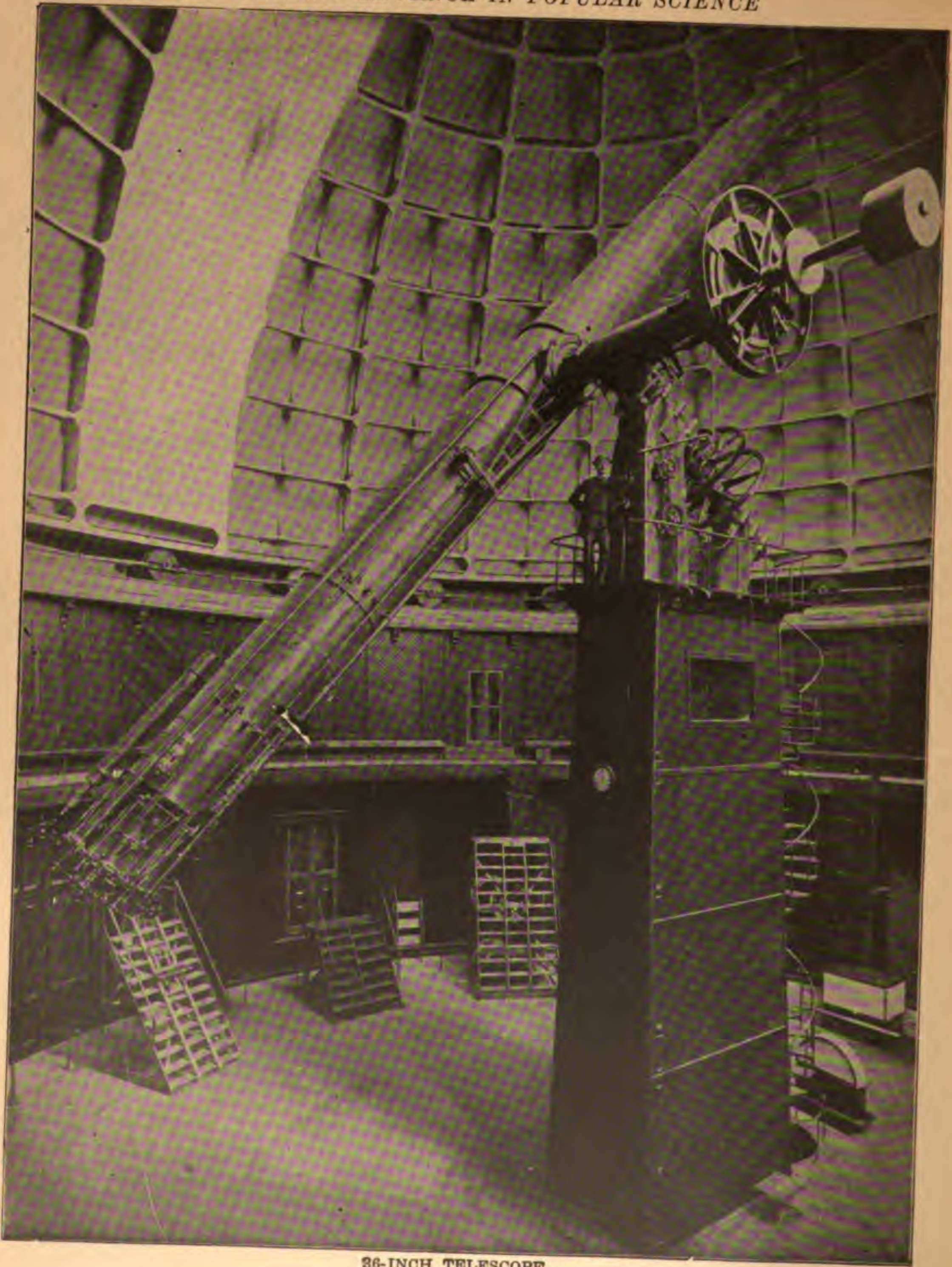
Describe the great Palace of Versailles.

Mention items of interest in connection with Italy.

BOOK IV

RECENT ADVANCE IN POPULAR SCIENCE

Present-day Science with which all Should be Familiar.
Knowledge that Enlarges our Mental Horizon and
Gives us Clearer Ideas of Nature's Methods
of Work. Sparks of Science
For Young and Old.



36-INCH TELESCOPE,
At the Lick Observatory.

RECENT ADVANCE IN POPULAR SCIENCE

POPULAR SCIENCE REVEALING NATURE'S DEEPEST SECRETS.

Science is classified knowledge of things as they are and rests upon the foundation of facts. Theories are simply statements put forth as reasonable explanations of known facts. Whether or not the explanation in any particular case is the right one, depends on its ability to explain satisfactorily further facts discovered by later researches in the same department of nature study. Popular science means the body of knowledge that all well-informed men and women should possess. It has increased in extent as culture in general has advance.

Practical popular science is a science that can be utilized in daily life. Other branches of science are of such a nature that as yet we can make no practical application of them, but knowledge gained in their study elevates thought and thus gives us mental discipline that assists us to meet the demands of modern life. Illustrations of advance in both directions are at hand, and as we pass them in review observe how true it is that all advance depends on more observant study of nature. Her methods often are beyond our present capacity to imitate, but we may subsequently discover means of such achievements. We cannot say of any science that knowledge concerning it is of no value.

WONDERFUL ADVANCE OF AGRICULTURE.

Agriculture is the oldest science in the world. It is also the most important for civilization depends upon it, as well as our very existence. Yet it is comparatively recent that we have studied agriculture in a scientific way—that is that we have really studied Nature's methods of work in improving existing species of useful plants and developing new varieties, and seeking means of assisting her in that work. Wonderful results have been obtained, and the future seems to promise results of even greater importance. All this shows the working of Infinite Intelligence that controls the affairs of men. The population of the world is steadily increasing; the area of fertile land is a fixed quantity; there is only one way in which this increased population can be supported—we must increase the productivity of our land. Fortunately this can be done in two ways—in improving the tools wherewith we work and improving the product.

INCREASING THE AREA OF FERTILE LAND.

We cannot, of course, increase the total area of land. We can increase the area of fertile land and can prevent other areas from lapsing into infertility. The reclamation service of the United States is an instance of increasing the actual area of fertile land. This service is discussed in the "Interior Department" of our government. When the various reclamation projects now under construction shall be completed an area as large as the state of Connecticut, before of little value, will become a section of great fertility. The Salt River Valley in

Arizona was formerly a near desert expanse, now thousands of farmers in that section are raising millions of dollars' worth of produce in a country as fertile as Egypt.

And over the world other governments are busy with similar measures. On subsequent pages the great irrigation schemes in Egypt are discussed. As a result of the World War and consequent downfall of Turkey we may expect Mesopotamia and Palestine to become once more as fertile as in the days of Abraham. All this constitutes an agriculture advance of greatest importance.

STARTLING FACTS ON WHICH SOIL TREATMENT RESTS.

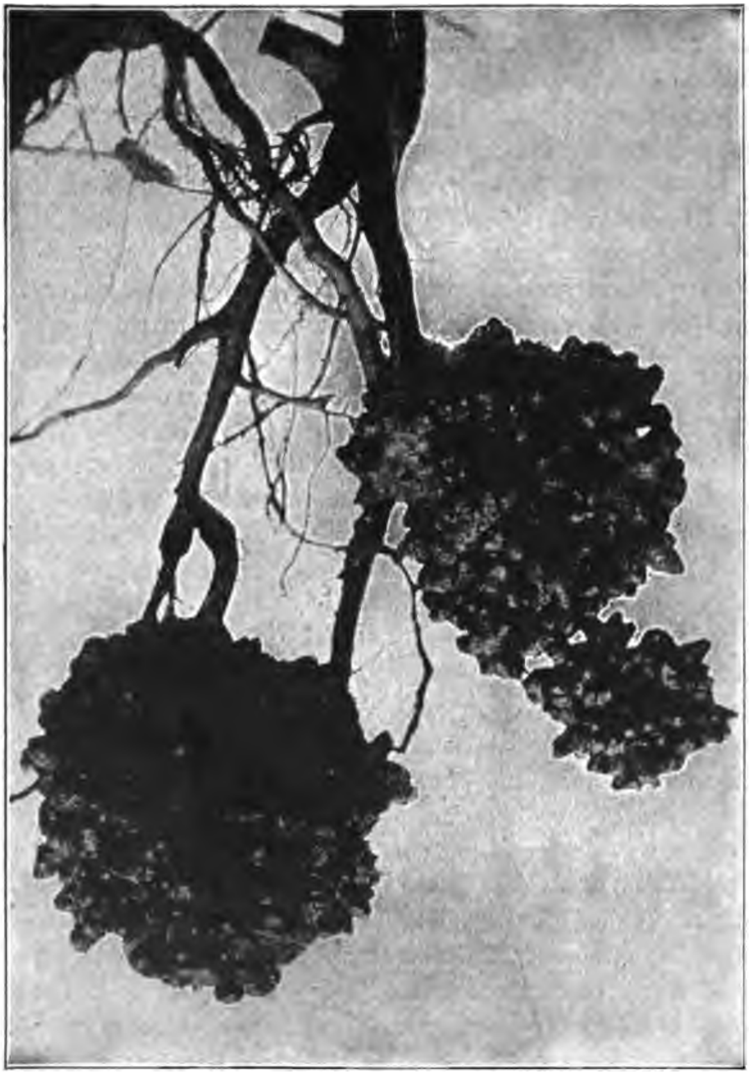
This is only one advance step. We have called chemistry to our aid, analyzed soil, and know the per cents of various chemicals in the soil. We know such facts as these: the first eight inches in depth of average soil an acre in extent contains, approximately, a ton and a half of nitrogen, two tons of phosphorus, and eight tons of potassium. But we also know that the average crop of the three great cereals, corn, wheat and oats, will extract from the average acre the following amounts of the chemicals. Just named in pounds:

	Nitrogen.	Phosphorus.	Potassium.
Oats	19.2	7.3	5.5
Corn	31.3	11.5	6.6
Wheat ...	20.2	5.9	5.

It was a realization of such facts that awakened the entire agricultural world to the importance of fertilizers. From various sources and in various ways Nature has deposited in the average acre a certain amount of chemical wealth like a deposit in a bank; the farmer has that wealth as a working capital. Every crop that he raises is a check drawn against that wealth. We have estimated what is withdrawn from the average acre by each of the three great cereal crops. One can now understand the importance of potash supplies, and why when the supply from Germany was cut off in the World War such exertions were made to find further supplies in the United States, for the chemicals withdrawn must someway be returned or soil bankruptcy will inevitably follow, and the time will come when the farmer's checks will be dishonored. No matter how hard he may work the ingredients that render soil fertile will not be present unless he made deposits to his credit. When we reflect that a crop of a billion bushels of wheat in the United States removes 72,000 tons of nitrogen from the soil, we understand the immense importance of the great nitrogen fixating plants the government erected at various places. Their product will be needed to sustain the fertility of our soil in days to come. All these questions have only recently been thoroughly studied. We now know how to build up exhausted, worn-out soil. Many thousand acres of land in our Eastern States have been abandoned; yet science has shown how to rejuvinate the soil and give it more than aforetime fertility.

IN MOTHER NATURE'S SCHOOL.

But we have of late years been learning a lesson from Mother Nature. She knows all about the importance of nitrogen and so for ages she has utilized the service of useful bacteria to keep her soil fertile, knowing that in time of need her latest children, men would learn the secret. Just as she sets myriads of helpful bacteria at work in our body to conserve our health she utilizes lower forms of life, in the first place, to conserve the health of her soil; and then the health, prosperity, and well-being of her ns of plant life. One of the sting chapters in Nature's book ge, which has been known to a few is now open for perusal by all. earn from it.



All plants of the leguminousa order are hospitable to nitrogen fixating bacteria, also all plants of the clover family, such as red and white clover, and alfalfa. What quality it is that attracts bacteria is unknown.

NATURE'S NITROGEN FIXATING PLANTS.

We make much of the immense nitrogen fixating plants the government has been building. Mother Nature has had nitrogen fixating plants in operation for ages. A few years ago it was learned by investigators that the swelling or tubercules which appear on the rootlets of certain plants are neither diseases nor abnormalities, but are in some way related to the vigorous growth of vegetation. Upon cutting open one of these enlargements or nodules and investigating by a microscope we find that this arrangement is the mutual advantage of plant and bacteria. This special relation is called symbiosis. The plant furnishes the home, the bacteria reciprocate by furnishing food for the plant, by taking nitrogen from the air, the water or any handy source with which they are in contact, and preparing it for the plant. Nature thus furnishes an object lesson; it is for us to profit by the same. We must help nature work by supplying worn-out soil with these helpful allies. We must breed the bacteria, invent some method of keeping them in stock, and contrive some means of transporting and setting them to work. All this has been done.

SETTING BACTERIA AT WORK.

The contents of a tubercule or swelling are put in a solution containing some stimulating substance like potassium phosphate. There they multiply at a prodigious rate, not in arithmetical, but geometrical, progression, and we know what that means. For each original bacteria there are soon billions, ready for work. Then absorbent cotton is dipped into the fluid, and subsequently dried in chambers free from dust, the obliging bacteria go to sleep and remain quiescent for an indefinite time. The cotton can be sent through the mail or by other means of transport; subsequently, when it is soaked in a suitable mixture, the bacteria resume business and in a very few hours produce as many gallons of fluid charged with bacteria as are desired. That fluid sprinkled over the ground will produce wonderful results. The bacteria at once hunt around for plant rootlets which will furnish them a home, and they commence at once to feed their host, and the crops thrive accordingly.

HOSPITABLE PLANTS.

The results are wonderful in themselves. But it has been found that some plants like peas, beans, and clover prove such hospitable hosts to the transplanted bacteria that they leave the soil in fine condition for the succeeding crops. Ordinary crops such as cotton, wheat or potatoes, show a great increase in productivity, in some cases several fold, when raised in soil after it had been thus inoculated and grown one crop of hospitable plants for the transplanted bacteria. Thus we are learning that just as the health of our bodies depends upon the presence of innumerable bacteria to digest the food and fight our battles with invading foes, so does the health of the soil and consequent crops depend upon the presence of infinitesimal bacteria to prepare nitrogen and foods for the plants, and just as by inoculating a patient with some helpful bacteria to fight off, say typhoid fever, we conserve the health of the body so we can furnish to soil deficient in helpful bacteria a fresh supply and thus conserve its fertility.

EVIDENCE OF INFINITE INTELLIGENCE.

This constitutes only a beginning of the new knowledge; or rather, let us say, of old knowledge now becoming common property, and of new results arising from practical applications of the same. This constitutes an exceedingly interesting chapter in the unfolding story of Nature's work, and the wonderful results that follow from a study of her methods. We can take only a general survey of the field, but vistas of exceedingly great interest open before us. We must understand that when we talk about Nature's methods of work we mean the

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LUTHER BURBANK, Naturalist

Renowned for research work in plant life. He has succeeded in originating many varieties of fruits, vegetable and plants in his laboratory at Santa Rosa, California.

outworking of Infinite Intelligence that controls the universe of things and is especially noticeable in the plant world.

A MUTUAL AID COMPACT.

At present, in order to secure the best results all useful plants and vegetable, nuts and fruits need the fostering care of man. But ages before man undertook this special work, what seems to be a working compact, one helpful to both parties—appears to have been perfected between plants and insects. Let us restate this as follows: Infinite Intelligence so shaped the development of plants and insects that they became more and more necessary to each other, each one more adapted to the part it was to take in this mutual aid society. Plants in order to do well need to exchange their pollen with other plants of like species. Insects are the flowers' messenger boys in this service. Yes, all varieties of bees, ants, moths, butterflies and even humming birds are Nature's assistants in this work. To pay insects for this great service, plants developed flowers beautiful to the eye, showing to attract attention, secreted pleasing perfume, and especially drops of honey on which insects feed. Mankind has been for weary centuries indifferent to this lesson of Mother Nature. At last we have learned the secret. We have learned that we can assist plants in exchanging pollen, and that by a process of selection we can induce plants to make modifications in their growth and thus we assist Nature in generating new species of plants and fruits. In this work we are simply following Nature.

PLANTS CHANGE ACCORDING TO ENVIRONMENT.

All forms of organized life whether you have in mind plants or animals vary or react to their environment so that in process of time, plants from the same locality, so like each other that we speak of them as belonging to the same specie, as they spread from their home locality and so are exposed to different surroundings, become in appearance, in color of flower, in fruit, and in other respects so different that we speak of them as belonging to different species. Left to herself, Nature effects such changes very slowly, so slow in fact, that formerly we were under the impression that a specie of plants could not be changed, we spoke of species as being immutable.

IMPROVING PLANTS BY EDUCATING THEM.

It has remained for Mr. Luther Burbanks as one of the pioneer workers in this field, and other patient experimenters to prove that the whole plant world readily responds to what we might call education; that is to say we can assist it to change, to take on new characteristics in bearing qualities, in manner of growth, so as to enable it better to serve our needs. To illustrate from the animal world, we have many different kinds of horses—draft horses, racers, etc., and the expert breeder knows how to breed different varieties of horses. In poultry we have developed some varieties that are expert layers, some are trim fighters, others grow large for eating purposes. In cattle some are noted for milk giving propensities; and so of pigs, sheep, etc., different varieties are produced. There is absolutely no difference in the plant world. It has been discovered that by controlling the exchange of pollen, by bringing pollen from plants somewhat distantly related, from other sections of the world, and by assisting Nature in selecting, we can develop plants almost to our liking. The plant experimenter can form a mental picture of a plant modified as he would like to have it, and go to work with confidence that he can produce the plant he has in mind at least proximately. This has been done time and again, but it is not an easy matter. It requires a knowledge of plant heredity and patient skill in selection, but most encouraging results and results on a large scale have been achieved.

WONDERFUL POSSIBILITIES.

It is this wonderful new knowledge that paints the foreground of agricultural hopes in such bright colors. Judging from what has been accomplishd, it seems not unreasonable to conclude that a further use of known methods will virtually double the most of our present farm crops. What intelligent farmer now cares to spend his energies in keeping common barnyard stock when he can get improved breeds of cattle and horses, swine and poultry? The time is at hand when the up-to-date farmer must have improved (that is educated) corn, wheat, oats and potatoes. The Burbank improved potato has added millions of dollars to the wealth of this country. Centuries ago, the ancestor of our corn was known as the teosinte plant. A rudimentary cob about as big as a pencil supported a few scattering kernels. The portly ears of today are the product of a long course of training and care by man. The most important steps in this development have been taken within very recent dates. The boys in our corn clubs are teachers, educating corn. We have no reason to think the end is at hand.

PEAS MADE TO ORDER.

To illustrate what can be done in this matter we might consider an order given Mr. Burbank to develope a pea suitable for canning purposes. It was necessary to meet several conditions. The pea must be a variety that would mature all its pods at the same time; it must bear individual peas reduced, but of uniform size, sweet and of a superior flavor. By the simple process of assisting Nature in selection, selecting rigorously only peas that met some one of the conditions he had in mind, Mr. Burbank developed one vine in three years time that produced peas meeting all conditions. The company giving this order, in three years more time, were able to produce peas of this superior quality sufficient to plant several hundred acres, and the Empson Pea Canning Industry was started that has added millions to the value of California products. Here was a pea made to order; or let us say, given expert education in a certain direction.

WANTED—A PERFECT PRUNE.

A prune is a plum, but, then, not every plum is a prune. The fruit industry of California desired a perfect prune, that is to say, they wanted a plum that could secrete a large percentage of sugar and store it in the juices of the fruit; possess a skin-covering having the peculiar quality of cracking in just the right way when the fruit is plunged into an alkali bath. The tree on which the prune grew must be a good yielder, the fruit must ripen early in the season while the days are long and warm and before the equinoxial rains set in. It must drop from the tree in exactly the right stage of ripeness, so that the orchardist may not be put to the trouble and expense of picking it. The fruit must have a small stone, it must be a free stone, and, finally, as a climax it should dispense with the entire stone.

AFTER LONG YEARS OF EFFORT.

Mr. Burbank spent well onto forty years of work before he developed the prune that met these specifications. He mingled the ancestral strains of European prunes, of California prunes, and of plum stock from Japan. He selected rigorously only those seedlings that approached in some one respect the qualities he desired. He mingled the traits of such selected seedlings, finally in 1912 he succeeded in producing the perfect prune. It was truly a new creation. The value of this kind of work is not in any particular result attained, valuable as that may be, but the great lesson is this—plants, fruits, nut producing trees may be made to vary in almost any direction to very great extent, provided the worker will mingle separate ancestral heredities and assist by rigorous selection.

MOTHER NATURE GLADLY ACCEPTS OUR HELP.

It is impossible to even mention all the new varieties of plants that have been produced. Nature shows a most obliging disposition. For weary centuries, she has done her work by the aid of her messengers—the insects—and natural selection; now she seems very willing to avail herself of the help of men. She has responded to our efforts with seedless oranges, seedless apples, and pitless plums. In fact she seems willing to dispense with seeds and pits in most any fruit, if men will only undertake to perpetuate the species in some other way. But one part of her work she absolutely refuses to give up. If we wish to develope new varieties we are compelled to fall back on seeds in which are mingled ancestral traits from distant localities or of species long exposed to different environments, then only are the potentialities of a new creation introduced into the mysterious citadel of life within the germ cell itself, that part of the work remains indifferent to mere human advances.

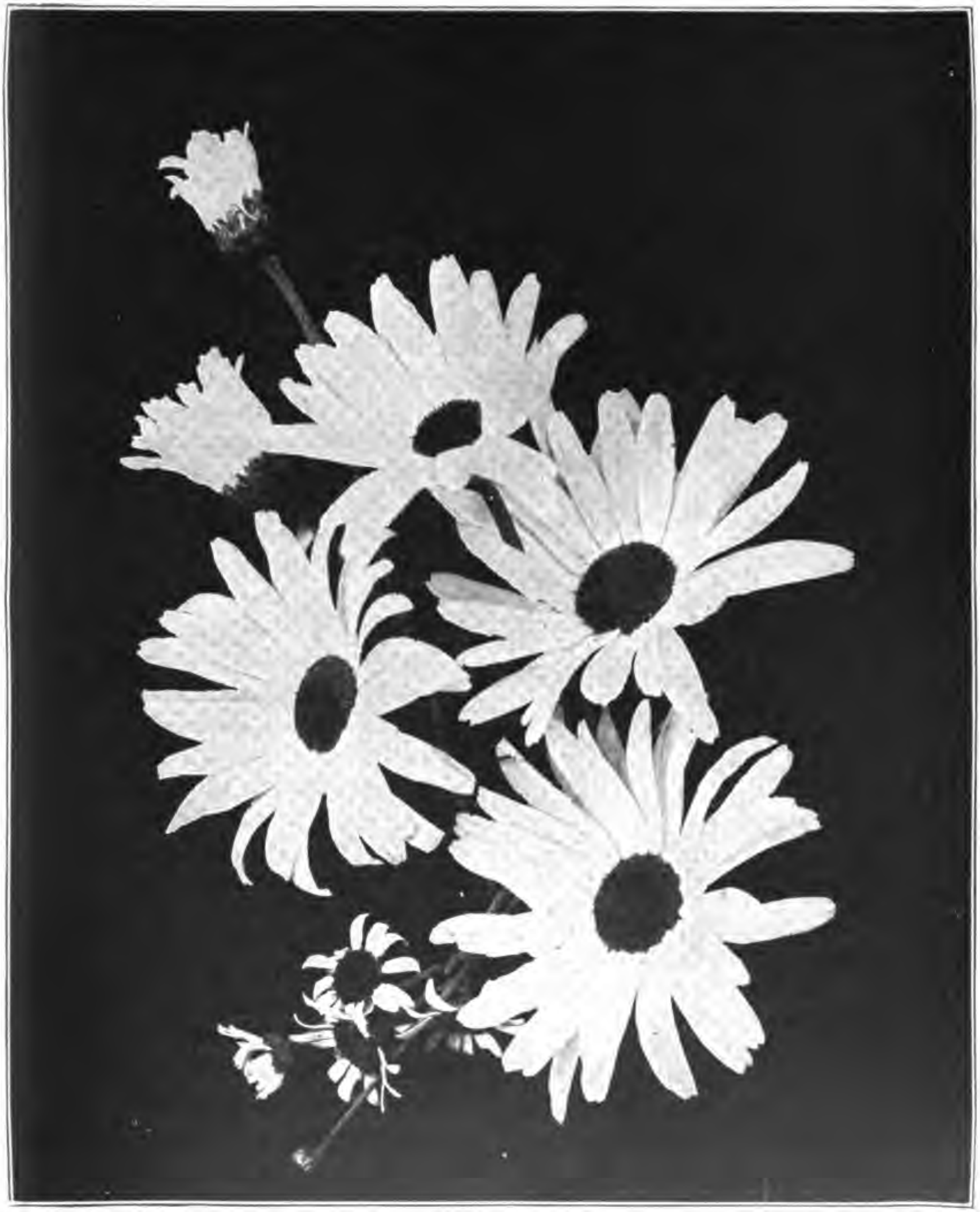
SOME OF THE RESULTS.

Working as just pointed out, new fruits have been produced for which new names had to be coined. The Citrange is neither an orange nor a lemon, but it is a new citrous fruit resembling an orange, hence its name. Nature by her slow, deliberate methods had not got around to such an anomalous fruit, but human efforts speeded up her work. Responding to Mr. Burbank's helpful efforts, Nature has, in cases, doubled the size of various fruits, flowers, and esculent roots. She has produced white blackberries and blue roses in answer to his experiments. The fruit industry of California has been almost revolutionized by the hundreds of new productions—plums, cherries, quinces, strawberries, etc.,—that Nature has been induced to provide. Take the plums, to illustrate. Mr. Burbank sent to Japan for some plum seedlings there grown. In the primitive long-ago plums were growing, let us say, in Persia. In her deliberate way, Nature set them traveling. Some went west to Europe, then crossed the ocean to America, and finally crossed the continent. Other plum stocks went east and finally settled in Japan. Mr. Burbank now helped the Oriental traveler across the Pacific and introduced them to their long forgotten kindred. Now by mingling their diverse ancestral traits and rigorously selecting the most promising seedlings produced, he created literally, new species of plums possessing an astonishing array of desirable qualities, beautifully large, luscious fruits, and again Nature was induced to dispense with a stone, the resulting plum is solid fruit which can be cut like a potato.

Photographs from Luther Burbank.

THE ORIGINAL ROYAL WALNUT TREE.

This tree is only 22 years old; 96 feet in height; with a spread of 64 feet of branches; with a girth of 9 ft. 6 in. s the largest walnut tree of its age in the world. Mr. Burbank combined ancestral strains of two species of wal- s that, separating in the long ago, are now growing on the Pacific and Atlantic slopes of the continent, thus as- ing nature to produce a new specie of walnut trees.



Photographs from Luther Burbank.

THE SHASTA DAISY.

Truly a floral creation. Mr. Burbank combined ancestral strains from daisies of three continents, which nature was powerless to effect without the aid of man, and then assisted further by rigorous selection. The result is this marvelous flower. The blooms measure four or five inches across, and are pure glistening white in color.

ASTONISHING FRUIT UNION.

The plum-cot is neither a plum nor apricot, but is a worthy descendant of both, and impartially combines the good qualities of its parents. It is a large and luscious fruit equally pleasing to the eye and the palate. The pomato is a union of the potato and the tomato. Nature was evidently a little in doubt whether to ripen the new fruit in the ground or in the air, so she compromised by ripening it on a potato vine, or one that looks like a potato vine growing upside down. The fruit is shaped like a tomato, but has a nice white skin like a potato, and is fragrant and juicy. The blackberry-raspberry is neither blackberry nor raspberry, but a delicious berry that deserves a shorter name. Then we have the strawberry-blackberry and other strange hybrids. In the peach-almond Mr. Burbank comes near killing two birds with one stone, since Nature has produced a fruit that is a delicious peach in appearance and taste, but possessing a stone not greatly different from an ordinary almond. Mother Nature must be surprised and perplexed at the results she has produced in working with her new ally.

NUT-BEARING TREES.

Nut-bearing trees have been induced to vary in two ways. The dwarf chestnut trees begin to do their life work in raising chestnuts when they are only six months old and about three feet high. Some of these willing workers when only one or two years old are flat on the ground with their weight of burrs, well filled with nuts. On the other hand the Royal Walnut tree is a wonderfully prolific bearer, on the tree shown in our illustration, 45 bushels of nuts were grown in one year. Another astonishing feature about this new walnut is its rapid growth. A tree growing as fast as the Eucalyptus tree but producing the finest of walnut timber for furniture making, and such a quantity of edible nuts is a very acceptable gift from Mother Nature. Perhaps it's her way of encouraging us to continue our good work.

A WEED BECOMES A BEAUTIFUL FLOWER.

Speaking in terms of geological time flowers are regarded as a late device with which plants are equipped to attract the floral messengers, mentioned as being essential to their well being. As a consequence, flowers are very susceptible to modification at the hands of men. It is as if Nature, realizing that man is now her most efficient co-worker in producing new varieties, is willing to please him by modifying the flower in anyway he wishes. It would require a large volume to describe the different floral creations Mr. Burbank has assisted Nature to produce. The dahlia is a fine looking flower, for some reason Nature gave it an unpleasant order; as a result of judicious selection, Nature replaced that perfume with the fragrance of the magnolia. The common white daisy in our eastern fields is a pestiferous weed. Mr. Burbank introduced to that weed Oriental cousins from Japan, and plodding stay-at-homes from England and Germany. He mingled their heredities. He gave years to selective work. Result,—the Shasta Daisy, —a beautiful flower. This is only one of countless instances that could be mentioned.

TRANSFORMING THE ARMOR-BEARING CACTUS INTO A USEFUL FOLIAGE PLANT.

The arid semi-desert plains of the Southwest are in many sections, covered with cactuses, each single plant of which is dressed in a coat of spiney armor that defies the efforts of the jack rabbits and such browsing animals as come that way. As it grows in the desert, it is one of the most marvelous plants that nature ever perfected. It is the result of a battle for life extending over many centuries against all sorts of discouragement—and the plant triumphed. A nutritious forage plant, growing in the long, long ago, on our western plains, when all that section was a scene of smiling fertility—verdure clad plains, abundantly watered, sparkling lakes and gently flowing rivers—was forced to meet entirely different conditions of growth. The water gradually ceased from off the land and near desert conditions supervened. Then that plant put up a fight for its life. It sent its roots deep into the earth; it transformed its structure, its leaves become thick cellular slabs in which it stored up water against a time of need; it become nearly as juicy as a watermelon, ninety-two per cent of it being water, but it lived while other plants died. Then it had to arm itself against thirsty and hungry animals, and so it covered itself with a coat of spines. And then for centuries it lived in the arid semi-desert section of our country, bidding defiance to climatic changes, to men and animals alike. It became rough and uncivilized just as men do when forced to hard conditions of life.

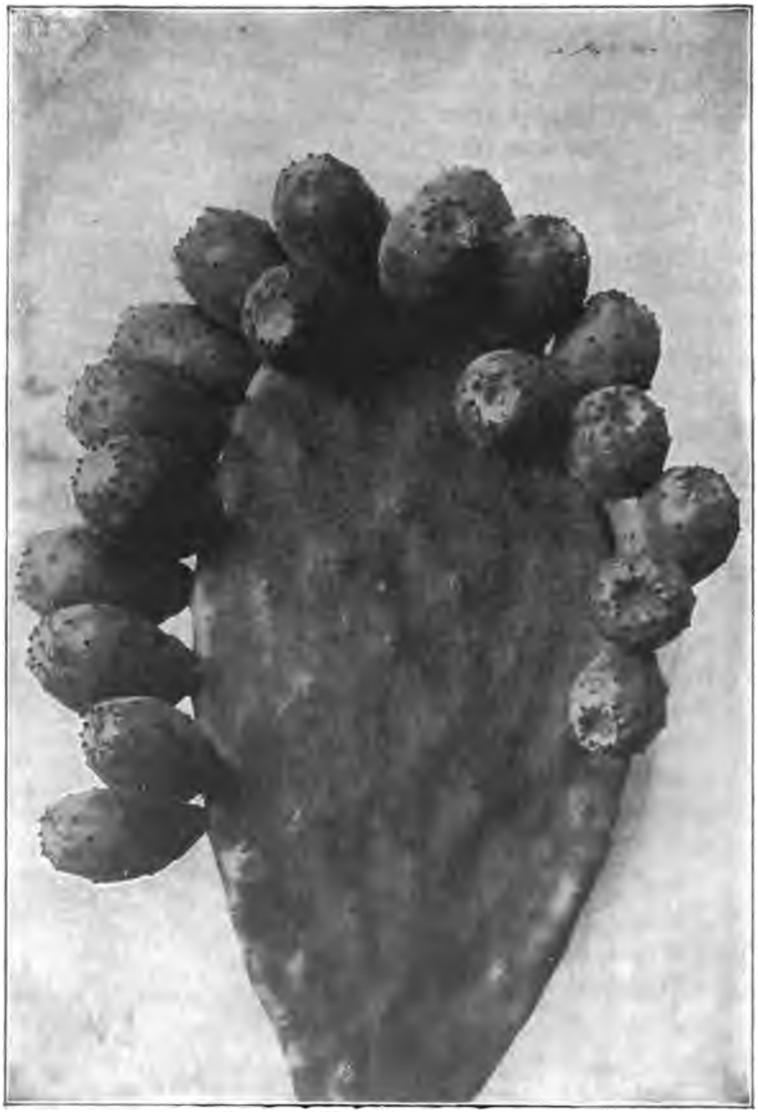
THE CACTUS RECLAIMED.

What we have described is the cactus in its wild, uncivilized state. Such a valiant warrior plant, possessing so many excellent traits of character, should be rescued from its unfavorable surroundings, treated with kindness and thereby induced to lay aside its defensive armor, and resume its useful position in the plant world. Mr. Burbank has accomplished these desirable results. It is perhaps the most important of all his plant work. It was certainly a work of great difficulty. It required fifteen years of effort—much of it painful effort, for the cactus made a vigorous fight to retain its independence. Like defiant tribes of men, it wanted to let alone. It sent its little spines by the myriads into the clothing of the investigators, which, however, was only a sort of no-man's land for them, and they steadily worked their way into the flesh making life miserable. Mr. Burbank collected specimens from all lands. He made experiments in pollenization with thousands of specimens, he selected from among millions of seedlings, he persevered year after year. But he won. He developed a spineless cactus that is the most wonderful forage and food producing plant in existence. When the cactus surrendered, it did so in a cheerful, whole-hearted way. All its old fighting energies were turned to peaceful ends. Nature made only one reservation. The new cactus is seedless. It is as if Nature said, "You win. My desert child shall serve you, but it is an individual affair, if you want more you attend to future plants. I will not bother to perfect seeds."

THE CACTUS REPAYS WEARY YEARS OF SCHOOLING.

What shall we say to plants so very productive that they produce a hundred tons of splendid forage, for all forms of animal life to the acre, yearly. But then it is a fruit bearing plant. Put down to its credit a great many other tons of edible fruit to the acre, and finally it is like our corn, a wonderfully versatile plant, it cheerfully lends itself to a multiplicity of useful services. It will grow most anywhere; it is not all partial to desert, sun-dried expanses;

it enjoys fertile surroundings as well as other crops and responds to the same; perhaps to enjoy such surroundings was one of the inducements for laying aside its armor clad, desert dress.



A LEAF OF THE SPINELESS CACTUS.

The enlarged leaf or branch of the cactus is called a slab. In the spineless cactus the surface is as smooth as that of a watermelon, thick and juicy. But notice the abundance of berries, or fruit growing on it. These berries make fine jam, jellies, etc.

LISTEN TO WHAT NATURE SAYS.

Measured in dollars and cents this is a wonderfully important achievement. But reading between the lines we find a message from Mother Nature of deepest worth. Plants are amazingly like human beings. No matter how rough, uncouth and forbidding men may be, how low fallen they may seem to be, there is in each one a substratum of good if we can only touch the righ chord. So it is with plants. We may call them weeds, seemingly of no good, perhaps poisonous in character, growing in borbidding localities, and yet, given a chance, treated with kindness, placed amid fertile surroundings, given an education (that is assisted in pollenization and selection), they may lay off borbidding traits, develop useful fruits, flowers, edible grains and bulbs. Every useful plant in gardens, orchards and fields has been educated by Mother Nature in many cases assisted by man. It has only been primary education so far, let us come to high-school branches with them. There are wonderful possibilities in the future.

HOW FAR CAN PLANT IMPROVEMENT GO?

Mr. Burbank asserts that, give us sufficient time, we can accomplish almost any desired result. Nature shows us that from a single type hundreds of species have originated unaided, though it required many thousand years for her to accomplish this result. Now that man has come to her assistance, results before requiring centuries can be achieved in a few years' time. What has been accomplished reads like fiction and prophecies of a greater future.

Stoneless plums point the way to a new world of fruits in which the stony or shell like coverings of seeds shall be bred away. Coreless apples, pears and quinces promise a time when all such fruits shall grow with sheathless seeds, compactly placed near the top, out of the way. Seedless raspberries, blackberries, gooseberries and currants can be produced with the energy now going to seeds saved, reinvested in added size or better flavor. Thorns can be bred off of berry bushes, being no longer needed for defensive purposes.

IMPROVEMENTS AWAITING THEIR TURN.

Countless improvements still await the kindly assistance of men. We should not be content with present results. Improvements are to be made in size, shape, color, texture, juciness, flavor, sweetness or chemical contents of fruits; improvement in the appearance, tenderness, taste, cooking quality, and nutritious elements in vegetables; improvement in length and strength of fiber in cotton, flax, and hemp; improvements in size, flavor, solidity, thinness of shells of nuts; improvement in quantity and quality of kernels of grains; improvements in amount and chemical value of sugar beets, sorghum, coffee, tea, and all other plants raised for their extracts; improvement in the stalk and leaves of corn so that it will yield far more of forage. All these improvements can and doubtless will be made. They are all wonderfully helpful to the agriculturalist, for they turn loss in his work into profit, not simply increased profits but multiplied profits. Considering all this we may be excused for thinking the real agricultural age is just beginning. Its achievement is to be another factor in the wonderful new age on which we are entering. The dog is an educated wolf; the useful and uncomplaining hen, an educated jungle fowl. What will happen when we educate our useful plants?

THE RESISTING POWER OF PLANTS.

In many ways we discover that the forces of life—whether animals or vegetable life be considered—act as if endowed with intelligence, or at least we can say they are controlled by intelligence. Our own body —as we shall see—is its own best physician. Curative agents are secreted and poured into the blood that ward off diseases. We have learned to take advantage of that fact in all forms of serum treatment and vaccination remedies. But nature does the same thing in the plant world. Nature develops secretions in plants that enable them to resist disease producing bacteria or other harmful attacks. It is for us by helpful selection to assist nature to produce plants immune to insect pests. A few years ago the boll weevil was inflicting many millions of dollars' damage to the Southern cotton fields. It was noticed, however, that in fields utterly ruined by this pest there would be a few stalks of cotton here and there that developed their bolls just as usual. Examination showed that the weevils had begun their attack, but Nature had developed a remedy; that is, she had developed a sort of protective tissue which she had thrown round the invading weevil and smothered him. This is a beautiful illustration of our subject. Notice the plain hint nature is furnishing us. Preserve the seeds of these stalks that have developed this protective tissue and plant them.

The vineyard of France would have been ruined if nature had not developed a variety that could resist the invading parasites, in which process she was assisted by the intelligent efforts of men. In arid sections of the world, nature has developed drought-resisting plants. It remains for men to introduce these plants into our own

A FIELD OF KAFFIR CORN.

This view is that of a field in which no rain fell from planting to harvest time. This view shows how nature develops plants to meet emergencies. Let us help her in such work.

arid sections. In this way Kaffir corn has been introduced into the West and splendid yields of corn are obtained, even where no rain falls from planting time to harvest. In a similar way the Durham wheat is yielding fine harvest where formerly no wheat could be grown. Why not take the hint and help Nature? Why should not oranges grow in the Ohio valley?

CONCLUSION.

The new agriculture is accomplishing great results by learning what nature is doing or has done, and then helping the process along. Nature uses bacteria to feed her plants nitrogen. What wonderful results have been achieved by simply helping in this work. For countless ages Nature has been developing by natural selection the varieties of plants useful for man. At last the lesson has been learned of helping Nature in this selective work, and we see that we can produce new varieties of grains, fruits and tubers. We seem to be on the threshold of amazing advance. We can, by selection, improve every agricultural production. Improved corn, improved wheat, potatoes, fruits—even new varieties, if the old will not do—when threatened by grave dangers as the boll weevil, Nature kindly takes the first step, and it is ours to help her. Where is the limit to possible soil improvement? Nature doubtless has many a secret which we have not yet fathomed. Where shall we stop with improved varieties? The wonders of Nature are exhaustless. The new agriculture takes a worthy place in the new learning of the day.

WONDERFUL ADVANCE IN MEDICAL KNOWLEDGE

The human body is the most wonderful and complicated mechanism in the world. Without venturing into the deep questions of psychology, we can say that you, I, each one and all of us are intelligences in charge of a body, we are some way connected with it, and our earthly welfare is bound up with its physical welfare. It would indeed be strange if with the wondrous advance in other directions we had not learned more about our physical body and how to help Nature keep it in good running order, how to assist her to ward off disease and to repair the ravages of the same. All this is included under the general name of physiology and hygiene and is summed up as medical knowledge and pratice. All know that wonderful advance has been made in this direction. Medical theories and treatment of fifty years ago are antiquated, outgrown. Like all progressive science medical science is forging ahead. We cannot enter into details but there are certain broad, general principles all should know.

It is comparatively but a few years since many diseases previously attributed to diverse causes were traced to the presence in the body of infinitesimal parasites, variously called germs, microbes and bacteria.

PREVENTION.

Every year we are learning that, after all, about the best we can do is simply to help nature. Knowing in many cases the particular germs which cause diseases—say, yellow fever—and also knowing the means by which the germs are communicated to man, the first great step is to destroy the medium of communication. Wonderful advance has been made in this way.

YELLOW FEVER.

Not many years ago, yellow fever was a frightful epidemic in the South when it had once gained a foothold. Rarely more than a decade passed without such a visitation. Business was totally suspended in the afflicted area; shotgun quarantine was established. Thousands of lives were lost, while the money loss ran into the millions. But now we know the germs of yellow fever are introduced into the body by the bite of a certain kind of mosquito. The remedy at once presents itself. Drain the pools and swamps and otherwise destroy the mosquitoes. It was this course that stamped out yellow fever in the South, in Cuba, and in Panama. Who can estimate the saving of life and treasure such a discovery represents? It is not too much to say that without it there would to-day be no Canal in Panama.

MICROSCOPIC INVESTIGATION IN A MEDICAL COLLEGE.

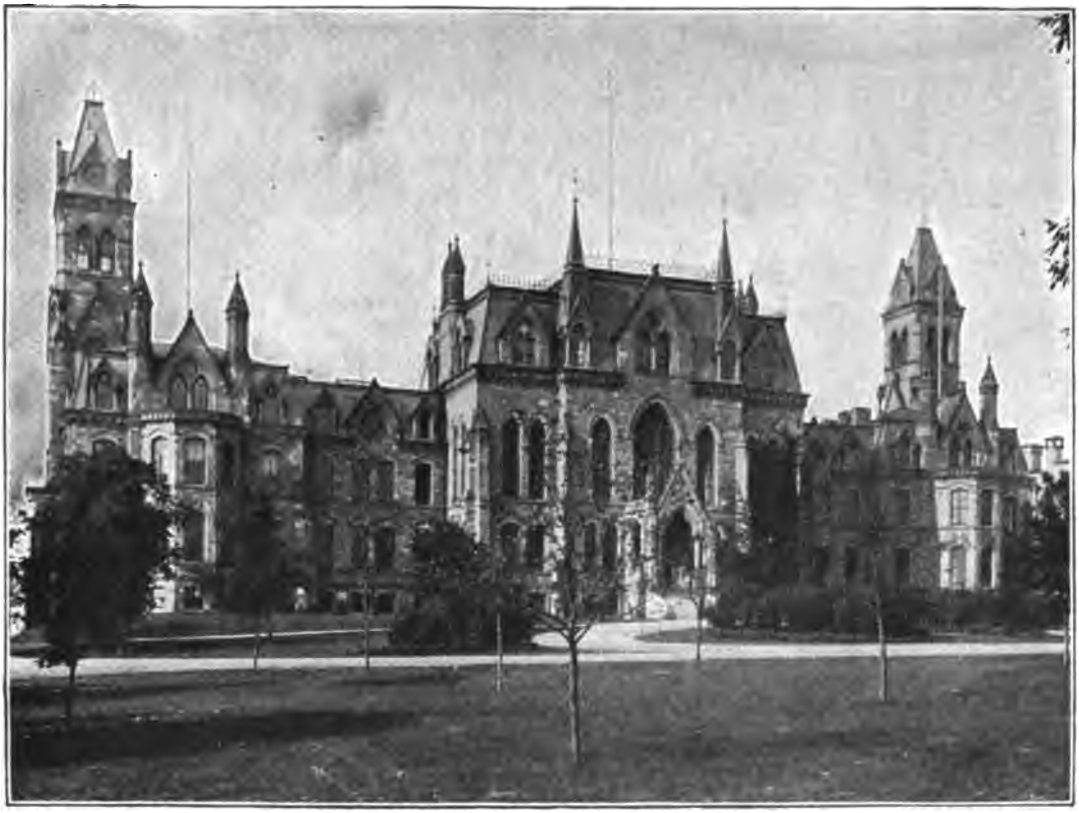
THE BUBONIC PLAGUE.

We have but recently seen San Francisco shake off an attack of bubonic plague by waging successful war against the army of rats which infested the city. The rats furnished living quarters for a certain kind of flea which caused the disease, because with their bite plague germs were introduced into the body. Not many years ago that plague would have swept the entire country, entailing frightful loss. It was that plague which several times ravished Europe. Modern science has learned how to deal with it.

COMMON HOUSEHOLD FLIES.

Many people are killed each year in India by tigers and the forces of town and state are enlisted to kill the tigers. Within the last decade we have learned that the common household pest, the flies, by their united work destroy far more lives in the United

States every year than all the tigers in India. They convey all sorts of disease germs, abundant in filth, to the food we eat, to the milk we drink. Modern science at once issues her warning—Destroy the flies. This result can be accomplished more easily than the destruction of mosquitoes in the swampy jungles of Panama. Before many years a large number of diseases will almost disappear in civilized communities because the fly will have been virtually eradicated.



A MODERN MEDICAL COLLEGE WHERE ADVANCED IDEAS ARE TAUGHT.

TUBERCULOSIS.

The great White Plague every year destroys between fifty and sixty thousand lives in the United States. It is common to every part of our country. We now know that it is a germ disease. There is, however, no animal or insect which transmits the germs to human beings. They float in the air. Every one of us probably inhales them many times in the course of the year. But in most cases the watchful sentinels in our bodies destroy the invading germs before they can gain a foothold, but in other persons whose vitality is low, the dread disease begins—and all medical science can do is, by the help of hygienic living, to prevent or delay the final victory of the invading host. However, we know it is a germ disease and that the insidious germs are in the air only because they have first been cast out of the lungs, in the sputum of a person afflicted with tuberculosis. We know at once the steps necessary to take in order to combat its further spread. The essential thing is to sterilize the sputum. We also know that sunshine and fresh air are of the greatest value in destroying the germs that do escape. So hygienic means of dealing with the plague are at hand. The entire civilized world is rousing to the conflict. The ravages of tuberculosis can be greatly staid, perhaps in the distant future it may be stamped out. Such a result will constitute one of the greatest victories ever achieved by science.

SURGICAL CLINIC IN A LARGE HOSPITAL.

SERUM THERAPY.

Advance in the direction of combatting diseases has been pronounced, the results are brilliant and the prophecy of future achievements is even startling. The thought is this: Life itself acts as if it were an intelligent force, or at any rate, a force acted on by intelligence, which in some mysterious way, making use of the unknown chemistry of the cells, distills from them the most efficacious antidote for the attacking disease, and if victory be won, the curative agent remains in the blood and that person is henceforth immune. The remedy that nature thus puts into the blood is called an antibody.

It doubtless varies for each disease. Just what it is, the wisest physician does not know. We are ignorant what gland or organ in the body is the secreting agent in the case of any particular disease, but we are certain what we have briefly outlined is the course nature pursues. For instance, in mumps, a germ disease, we do not give medicine for the disease itself. All we can do is to help nature allay inflammation, etc. Nature herself—or the forces of life—is at work and by some gland—the antibody—the remedy is being secreted and poured into the blood, by means of which the invading germs are annihilated and speedy recovery follows. But the curative agent, whatever it is, remains in the blood and, with rare exceptions, the patient is henceforth immune. In most cases of children's diseases the resisting forces easily conquer. But in others, like typhoid fever, the conflict is far more severe. The danger is the attacking forces may, by a furious onslaught, carry the citadel of life before the arrival of the reinforcements nature is hurrying to the beleaguered fortress.

SURGEON AT WORK.

HOW USED.

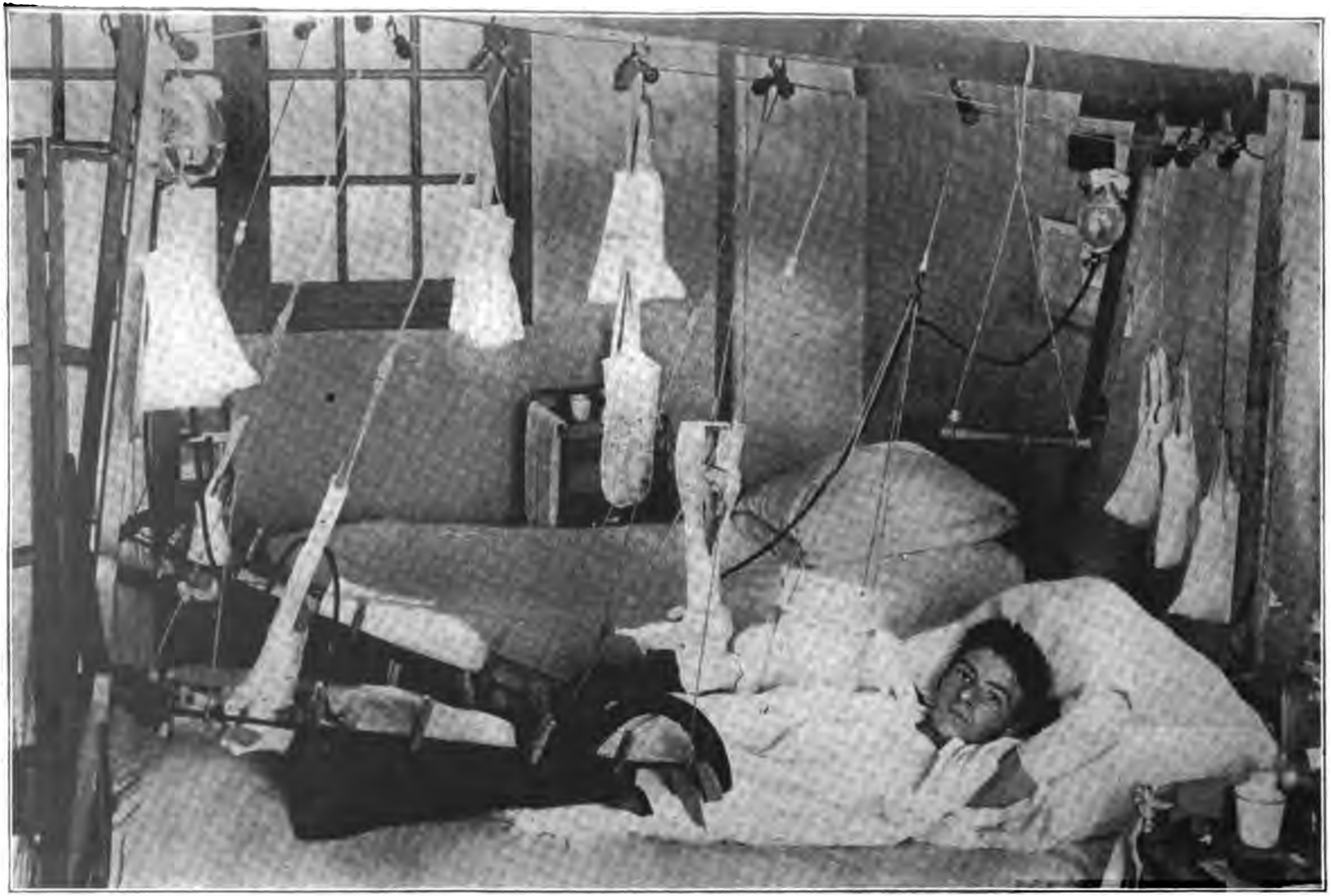
The great point is that we have finally learned how, in many cases, to use the curative agent that nature has herself prepared. We do not know its nature; we cannot discover it by the microscope, nor can we analyze it chemically—but we can use it. To illustrate, we take some animal, say a horse, and give it some disease—say, diphtheria. The forces of life in the horse act in exactly the same way as they do in man, and at once set to work to put into the blood of the horse the right remedy. Then we take from the veins of that horse some of this blood, and treat it so as to obtain from it the clear serum which contains the unknown curative agent for diphtheria. Now, if a child be attacked by that dread disease, we can, by injecting a suitable quantity of that immunized serum into its veins, supply at once nature's remedy for diphtheria, thus furnishing reinforcements to the forces of life at the very beginning of the conflict. That is antitoxin for diphtheria. It is an example of serum therapy, but it by no means is the only one. We use that same principle, and successfully so, for typhoid fever, hydrophobia, and with considerable success, cholera. Recently that dread disease, cerebro-spinal meningitis, was so treated. This latter disease was hitherto considered necessarily fatal. It will no doubt be successfully applied to other diseases. Vaccination against smallpox is an ancient illustration, empirically known—of this same principle.

MODERN SURGERY.

Surgery has also partaken of the great advance of modern times. It is not simply the increasing use of antiseptics and anesthetics we have in mind, but the boldness with which our surgeons now operate. The lacerated heart is sewed up, and even the heart ceasing to beat has been gently massaged through a hurried incision, and thus induced to resume its function. Weakened arteries are strengthened by delicately coiled springs; the brain is boldly cut into and tumors removed; whole sections of diseased intestines are cut out; new openings are made into the stomach. But we catch glimpses of possible actions in the future that bewilders us. We have been shown how to make arteries do the work of veins and vice versa. It has been proven in the case of lower animals that bones from one animal, from say a dog, can be transplanted to another and thrive. Such an important organ as a kidney has been transplanted from one animal to another, and went right on with its usual functions. All this hints of future possibilities that are absolutely startling. It has been soberly suggested that in the case of a healthy criminal condemned to death, he might sell his kidneys—for instance—to be exchanged for some diseased one, and thus save a valuable life slowly giving away before the advance of disease; but if that could be done, other parts of his anatomy could be used also. All this is now held possible by some of the best surgeons in America.

ASTONISHING SUCCESS OF MODERN PRACTICE IN WAR.

The great war afforded striking instances of the application of science in destroying human life; but on the other hand, it demonstrated wonderful advance in medical and surgical practices. The principle of preventive treatment, serum therapy and vaccination, was employed in the army and navy; and in the hospitals the triumph of modern treatment and modern surgery was pronounced. Wounds that in former wars would have been regarded as fatal were successfully treated. Hearts were sewed up. and the patient lived; faces were shot away, yet the wounds were healed and new faces supplied, if other means failed, a mask was made so tinted that when worn a casual glance would not disclose it nature. Artificial hands, arms, feet and limbs were supplied, the actions of which are so efficient that they go far to recompense the loss of natural members. All this constitutes a great advance which will not be lost in days of peace. The great lesson is being learned that in medical science, as in other scientific fields, we must follow nature's methods of work, and if possible assist in the same. All forms of vaccination and serum therapy are simply imitations of nature's work. It is boldly claimed by some schools of practice that the forces of life in the body are perfectly competent to grapple with every danger that threatens the welfare of the body and that all we can do is to assist nature in her work.



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THE AMERICAN HOSPITAL IN PARIS.

The hospital shown in this illustration is representative of the most advanced methods of surgery. Dr. Alexander Carrell in charge, one of America's foremost surgeons, is the inventor of a wonderful disinfecting fluid. Wounds that in former wars would have necessitated amputation of arms or limbs are now successfully treated. The soldier in this illustration had both arms and limbs fractured, yet he will recover without amputation. Notice the tubes leading from flasks of the fluid to the right arm and limb. On the battle fields we find the latest, most up-to-date methods of life destruction; in the hospitals, the latest, most scientific means of life saving.

OUR THOUGHTS SHAPE OUR PHYSICAL WELL-BEING.

Physicians of all schools now recognize that the mind exerts a wonderful influence over bodily conditions. Shell shock in the World War—that is to say the influence of the terrible explosions, not physical wounds—was a most real and dreadful malady. The wisest physicians in the service could suggest no remedy except rest. Two thousand cases in the hospitals of France were cured by the simple announcement of the signing of the armistice. That is only a striking instance of the power of thought.

The nervous system is the wonderful mechanism by which you, I and the rest of us are able to operate on the every-day plane of existence. The sympathetic nervous system is that part of the entire system that seems to control all mere bodily functions. In a large degree it is independent of our brain. Try holding your breath. You can do it for a little while but then the sympathetic system calmly issues its command. You breathe whether you wish to or not. But this system can be and is amenable in a degree to the command of the brain. It is this system that sets the mysterious chemistry of the cells at work and sends forth curative compounds—the wisest chemist does not know what they are—which cure various germ diseases—such as diphtheria. Many people think that right thoughts—that is healthy, optimistic, positive thoughts—will impell this potent system to issue its commands and restore to its proper function whatever organ is not functioning properly in case of disease. Hence the conclusion—as you value health refuse to think sick thoughts. Sing, laugh, whistle, for as the Bible says, "A merry heart doeth good like a medicine."

THE THREE STATES OF MATTER.

According to present theories, all material substances are built up of atoms and chemical combinations of atoms called molecules. The atoms themselves are extremely complicated structures. All atomic bodies exist in one of three states,—solid, liquid, or gaseous; and can be made to pass from one form to another by a sort of reduction ascending or descending, taking the three steps in the order named, or the reverse. The agents of change we employ are heat and pressure. Chemical combinations of atoms may or may not undergo similar transformation. It depends upon the nature of the compound. Heat may result in decomposing the molecules, setting free the atoms composing them and allowing many of them to combine with other elements as with oxygen when they are said to burn. As far as known, all gaseous bodies may be caused to assume first the liquid state, and then the solid state by the application of pressure, and subject to sufficiently low temperature. Much interest has been aroused by the successful application of these principles to air

THE WONDERS OF THE ATOMS.

In two directions, our scholors have made discoveries, which, when considered, lift the mind to higher planes of thought and open before us wonderful glimpses of nature's works. They lead in two opposite directions,—the science of the infinitely large, or astronomy; the science of the infinitely small or knowledge concerning the atoms. Astronomy is considered elsewhere. Let us now study what our scholars have to tell us of atoms, their properties and structure. This is necessary for all progress in civilization, seems founded on a more complete utilization of nature's vast stores of energy, as the energy latent in coal, first utilized by coverting water into steam. The age of steam was an age of wonderful progress. We made another step in advance when we transformed that energy into electricity. That subject we have carefully considered. In the mystery of the atom we are dimly conscious is involved the secret of boundless stores of energy, which if we learn its secret and learn to use it will mark the beginning of the most wonderful age of advancement the world has ever seen. Let us then take up the study of the greatest mystery in the world.

ALL IS RELATIVE.

If we venture to inquire into scientific research, we must hold ourselves in readiness to accept statements of magnitude that, to our human understanding are incomprensible. In science there is no near or far, large or small, slow or swift, or means of comparing time except in a relative sense. Our human mind can neither mentally grasp, weigh, nor compare scientific quantities. A second seems to us a short space of time; it is almost endless compared with some divisions of time scientists would have us accept. The microscope discloses particles far too small to be seen by the naked eye; such particles are veritable mountains in size compared to some dimensions that science reasons about. A bullet from a machine gun flies with amazing velocity; such velocity is virtually stationary compared with the flight of worlds and system of worlds in space; while no means exists to compare it with the speed with which electrons wing their way hitherward from the sun. And so it is with every measurement that science has to reason about; we must accept them, knowing that the human mind cannot understand. Only Omniscience can understand the scale, whether large or small, on which the universe is built; only Omnipotence can arrange the details.

WHAT IS AN ATOM?

Until the last decade of the nineteenth century it was generally agreed that atoms were the ultimate particle of matter. They were, to be sure, infinitesimally small, a great many millions of them in the smallest portion of matter we could see, feel, or handle. And it was further supposed that they were immortal, that is to say they could not be further split up or in any way destroyed. An atom of oxygen, for example, could be united with many other and different atoms so as to form a molecule of some substance, as, for instance, water. And in the case of that molecule it could by suitable means be split up so that the atom oxygen would be set free. But during all this time it remains an atom of oxygen; and similarly in the case of all atoms.

THE WONDERFULLY COMPLEX ATOM.

All this has now been changed. We understand that an atom is a wonderfully complex structure, fully as mysterious in its way as is the solar system itself. There is in fact, the strangest similarity between present day theories of atomic structure and solar systems like our own. It is as if Omnipotent power were to take our solar systems,—from the sun to the outermost planet,—revolving meteor streams and flying comets, Jupiter and his satellites, Saturn with his rings, and the belt of asteroids,—and compress all within the infinitesimally small confines of a single atom; and even then it would not approach the complexity of some atoms, as that of radium. Do your best to form such a conception as this, for it is in accordance with the teaching of some of our foremost scholars. Read again the paragraph concerning the relativity of all scientific teaching. The mind reels in the effort to mentally visualize this concept. The infinitely small atom, the scene of more complex structure than our solar system.

THE FOUNDATION FOR SUCH A STARTLING THEORY.

Such bewildering statements as these are not the product of fanciful reasoning, but are theories framed by earnest thinkers to explain facts established by the study of radio-activity. In considering the subject of electricity, mention was made of this property of matter, we must consider it with more care since it leads to such astounding conclusions.

Some substances of high atomic weight, as uraniun, radium, thorium, etc., are found to be the source from which issue X-rays, and swiftly moving streams of excessively minute particles, that can be separated into two groups, one of which consists of electrons, the other of particles carrying a positive electric charge; and in addition there is usually an emanation that we need not stop to consider. Let it suffice to remember that etheric disturbances (X-rays) and streams of particles are coming in ceaseless flow from all naturally radio-active bodies such as the substances above mentioned.

After most exhaustive research our scholars can only conclude that in such bodies, all of great atomic weight, the atoms, owing to their complexity, are in a state of unstable equilibrium, they are disintegrating and, in the act of disintegration they emit streams of particles that are the elements, you might say, of the atoms themselves, and set up disturbances in the ether known as X-rays. The electrons are now generally considered to be units of negative electricity. The particles with the positive charge, after some further transformation, turn out to be atoms of helium gas. In radio-active substances, then, we see complex atoms breaking down into simpler substances.

WE DISCOVER A NEW PROPERTY OF MATTER.

If heavy, complex atoms tend to disintegrate of themselves, may not such disintegration be a general property of matter: or, at least, may it not be that, under certain circumstances, all matter may become radio-active? A great many of our scholars think that both these questions are facts. Let us then bear them in mind. Certainly they should be so considered for whatever has been put together can be taken apart. Let us, then, consider that the atoms of all substances are complex, some exceedingly so, that they consist of swiftly revolving electrons, or systems of electrons (as in our solar system we have not only a simple planet, like Mercury; but a complex system like Saturn), and that they are either in a naturally unstable condition, or can at least be made to assume such a state, in which conditions they tend to break up. Some startling conclusions follow from this statement.

RADIUM AND ITS STRANGE PROPERTIES.

Radium has been mentioned among the lists of radio-active substances. For several reasons radium is of great interest. It was a study of its property that opened up the study of radio-activity, and with that, this flood of knowledge concerning the nature of atoms and, most wonderful of all, its prophecies of amazing results to come. Radium was discovered by Prof. Curi of

Paris and his wife. They were investigating the X-ray emissions of pitch-blend, and concluded that they were due to the action of some unknown element presence in pitchblend. As a result of very careful chemical treatment they secured a very small amount of white, crystaline substance that was so exceedingly radio-active that they named it, radium. It should be added that they did not secure it in a pure form but only as a salt in combination with chlorine or bromine. The small amounts they were able to secure exhibited all the phenonema of radioactivity, and in an abundance and unceasing measure, thus permitting a study of this new property of matter.

THE SOURCE OF CEASELESS ENERGY.

From a minute quantity of radium there are constantly emitted an endless succession of X-rays, and unceasing streams of electrons and positive ions. We can neither originate, stop, nor in any way interfere with the process. Its atoms are disintegrating in resistless unceasing numbers, and yet the number of atoms present is so inconceivably great that thousands of years will elapse before that pinch of radium will cease to exist. Being an exceedingly rare element, even rarer than gold in seawater, so rare that several tons of pitch-blend had to be worked over to secure a few grains, it was very expensive to produce. It was estimated to be worth about $1,000,000 a pound.

WHY SO VALUABLE.

It was supposed that radium by reason of its penetrating discharges would prove a curative agent in many diseases, and especially in cancer. It has been a disappointment in that respect, still it does have an effect, and many hospitals possess minute fragments of it. It has been discovered, of recent years, that rich deposits of radium ores, known as carnotite, exist in Colorado. Before the World War, large quantities of this ore were shipped to Germany. After the war began, the United States Government investigated the problem through the Bureau of Mines and proved that the production of radium could be greatly cheapened. The Government produced about eight grams. Some of this amount was distributed to leading hospitals. The fact is while radium is of immense scientific interest it is not otherwise of great importance. But thanks to its discovery and study we see wonderful possibilities for future advance. Some fortunate investigator by reason of its study is going to forge the key that will unlock a wonderful storehouse of good for man that for untold ages nature has guarded with jealous care.

WE USE ATOMIC ENERGY.

In order to glimpse the great possibilities just hinted we must speak of energy and the sources of energy that we can utilize with our present knowledge. In physics, energy is the capacity to do work. We speak of the energy of heat, of electricity, of running water, etc. All the energy we can utilize at present is the energy of moving atoms. It makes no difference what you are talking about whether the energy in burning coal or in moving water, it is the action of one system of atoms upon another that provides the energy we are using. This energy is often very great. Consider the latent energy in a mass of smokeless powder that hurls a three-thousand pound shot, thirty miles through the air, or consider the energy latent in a few bushels of coal, that can pull freight trains with a load of several thousand tons.

BOUNDLESS INTER-ATOMIC ENERGY.

A study of radio-activity, radium, and a consideration of statements regarding the structure of atom, leads irresistibly to the conclusion that within the atoms of any substance is confined an absolutely astounding amount of energy. All the energy that we can obtain by moving the atoms (by applying heat or damming water) is absolutely insignificant compared with the limitless energy within the atoms themselves. Remember we are dealing with the energy of particles, exceedingly small in themselves, but moving at the speed of many thousand miles a second, doubtless approaching one hundred thousand miles a second in some instances. If a cannon ball moving at the rate of only 20,000 miles a second, a slow rate of speed for these emitted particles, were to strike a target, the heat evolved would be sufficient to instantly dissipate that ball into vapor, so far flung you could not see it. The most careful computation establishes the fact that the heat evolved by the radium emanation is over three and a half million times greater than that let loose by any chemical action we can induce. Try your best to realize what that statement means. Remember all is relative.

AWE-INSPIRING STATEMENTS.

Prof. J. J. Thompson is one of the master minds in the domain of physical research. He concludes, after exhaustive consideration of radium, and profound mathematical analysis, that in a gram of hydrogen, a trifling amount, there is imprisoned energy sufficient to lift a million tons through a height of considerably exceeding 300 feet. Try and grasp the significance of that statement, a million tons, lifted 300 feet in the air by the latent energy in a gram of hydrogen! But this is not the limit. An atom of hydrogen is simple compared to an atom of, say, iron consequently the energy in a gram of iron is enormously greater than the energy of hydrogen. We are told that in a single copper coin there are nearly 7,000,000 horsepower of energy confined. The mind reels in trying to form a mental picture of what these statements imply. The suddenly liberated energy in a few thousand pounds of T. N. T. wrecked Halifax; yet the total energy thus liberated probably did not exceed the energy in that copper coin.

PRACTICAL APPLICATION.

But all thus far stated is of scientific interest only. The energy is there all right, what good does it do us? We can neither set it loose, nor tie it up in any way whatever. The problem is to find some way of drawing upon that exhaustless store. For ages barbarians hunted back and forth over mines of coal, ignorant of their existence. Centuries passed after coal mines were discovered before Watts invented a way of utilizing the energy latent in coal. We have now discovered our mines of energy, we are awaiting a Watts to show us how to use it. It is by no means a hopeless marking time, waiting for the fortunate investigator to appear.

WAITING IN HOPES.

What has been put together can be taken apart. What is theorically possible is generally practical to at least a limited extent. What men earnestly hope for, men will some day attain. Knowing that every breath of air he draws contains within itself power enough to drive the workshops of the world, he will find out some day, somehow, someway of tapping this infinite store of energy.

Human advance moves with constantly accelerating speed, one year counts for a cycle of former times, and so with confidence we may conclude that there will come a day in the unending succession of coming days when Mother Nature, with a smiling welcome, will greet some daring investigator on the very threshold of her last closely guarded treasure house and bid him enter. Then will dawn the greatest age in human advance that the world has ever seen.

THE UNIVERSE OF THE INFINITELY LARGE.

We have been considering the universe of the infinitely small. What a wonderful universe it is! We are inclined to measure everything by the scale of our human senses. That scale is utterly unreliable. The stone that you hold in your hand seems to be solid, inert, dead. On the contrary it is a universe of pulsing atoms, an inconceivable number of them; but how the mystery deepens when we understand that every atom in that infinite aggregate of atoms is a mechanism as wonderful as the solar system itself! Our limited senses tell us only an infinitesimal part of the mystery involved in that piece of stone. But all thus far stated about that stone pales to insignificance before the further fact that the most advance scientists of the day tell us that the solid stone is composed, in its last analysis, of nothing but centers of forces—that we name negative electricity, someway held in bounds by an utterly incomprehensible something we name positive electricity. Let us bow our heads before the mystery of matter, and see in what we blindly term Nature and natural laws, the workings of Infinite Intelligence, of Omnipotent power.

FACTS OF SCIENCE FOR EVERYDAY USE

It is a mistake to suppose that the word, science, includes only knowledge fitted for the special student and research worker. It includes a vast mass of information for the everyday use of all who wish to be well informed. Knowledge enriches the mind and adds zest to daily life.

In the following pages we have gathered and arranged in as systematic a manner as possible information of this nature covering many different fields of research. Of course, what is here presented is a fraction, only, of what might be considered. It is to be hoped that from this as a starting point the reader will continue his quest in other directions. A mind stored with such knowledge is better able to meet perplexing problems than one destitute of it. It is not the specific facts themselves that are of great value, but the mental drill gained in their mastery which strengthens every mental muscle and helps win the battle of life. It is mental reserve strength that wins. One whose mind is not well supplied with this varied information is soon exhausted, but if one has stored one's mind with well selected information it becomes a mental bank against which checks can be drawn in times of need and in the countless difficulties of daily life strength is found to solve the problems. And so we urge all to make a study of the pages that follow and faithfully test their understanding by aid of the review questions that conclude this section.

FACTS ABOUT AIR.

Air is the gaseous envelope at the bottom of which, on the solid or watery surface of the earth, we live. It constitutes a veritable aeriform ocean, resting upon the water and land. It is a mixture in composition (not a combination) of two principal gases, oxygen and nitrogen, nearly in the ratio of one to four. But there are present small quantities of argon, carbon dioxide (carbonic acid gas), water vapor, and traces of other gases. Oxygen is the essential preservative of life, but unless diluted so to speak, with nitrogen, its strength would destroy life. Carbon dioxide, though small in amount, is the source from which palnts obtain their carbon, and the presence of this gas in the air has a great deal to do with climate, since it is a great retainer of heat radiated from the surface of the earth, which is the only way air is heated, since the passing of light and heat in sunbeams does not directly heat the air.

CHARACTERISTICS OF AIR.

Like all gases, air is compressible and elastic; it transmits sound, and as compressed air it is used to transmit mechanical power; it can also be liquefied and even be reduced to a solid state provided the temperature be made sufficiently low. It extends for an indefinite distance above the surface of the earth, in other words, the aerial ocean is of indefinite depth, but it so rapidly decreases in density as the distance from the surface increases, that half its mass is within four miles of the earth; in this respect, the aerial ocean differs from the watery one, the density of the latter not increasing with the depth. It is supposed that at the height of, say 100 miles, above the surface of the earth rarefication of the air becomes so great that it ceases to be noticed; still there is no reason why it should not extend still farther in space. It, of course, has weight and consequently exerts pressure; at the general surface of the earth, and under normal conditions, the pressure is nearly fifteen pounds to the square inch, that weight is spoken of as the pressure of one atmosphere. But however far it extends, it is a part of our earth, just as truly as the ground on which we walk—it is held to the earth by the attraction of gravitation, just as is the water, and it revolves with the earth, at least until we reach excessively high altitudes. We know but very little of the meteorological conditions in the upper strata. Balloons carrying men have only gone to the height of a few miles. Small balloons, carrying automatic registering barometers and thermometers, but of course no passengers, have been sent up and have reached enormous heights, one ascending thirty miles; thus conditions approaching those existing in space must have been encountered.

AERIAL CURRENTS.

It is considered that the winds which blow fitfully and in different directions on the surface of the earth, become aerial currents in the upper reaches of the atmosphere, setting steadily to the northeast in the northern hemisphere and to the southeast in the southern. Such currents are the analogues in the aerial ocean of the vast ocean currents which pursue their undeviating course, regardless of the surface winds and storms.

COMPARISON OF THE TWO OCEANS.

There is this difference between the two oceans, both alike resting on the solid surface of the earth. The storms, cyclones, and irregular waves (winds) of the one are at its bottom, while the irregular movements of the other are on its surface. In ocean depths eternal calm reigns; in the upper air all is orderly, the mighty currents setting steadily in one direction. The ocean tides are doubtless small in volume compared to the vast atmospheric tides that follow the moon in its flight. Though the density of the upper air is certainly very low, yet if motion through it be sufficiently rapid, the friction produces heat, consequently, when meteors from space enter its upper confines traveling at a speed of some hundreds of miles per second, they generate such enormous heat that they are consumed, the most of them at heights exceeding fifty miles, but very few being of sufficient size to reach the surface, and in such cases the heat is sufficient to explode them some miles above the surface. Hence, the air is a protective covering for the earth. Were it not for its presence we would be exposed to a merciless bombardment from space far more destructive than any occasioned by human effort.

FACTS ABOUT THE OCEAN.

The ocean is the body of salt water which covers about three-fourths of the surface of the earth, thus an area of nearly 148,000,000 square miles. The average depth of the ocean is estimated to be about 13,000 feet. The greatest depth in the Atlantic is near the island of St. Thomas, 23,250 feet; the greatest known depth in the Pacific is near the island of Guam, 31,614 feet. The general contour of the ocean bottom is the same as that of the dry land. That is, there are great low-lying plains, elevated plateaus, mountain ranges, and isolated hills, forming archipelagoes and solitary islands of the ocean. In case they do not quite reach the surface they form shoals, often dangerous for navigation. The bottom is covered with fine red or gray clay or, in certain regions, with ooze of organic origin.

COMPOSITION OF SEA WATER.

The water is nearly constant in composition, and it contains considerable mineral matter in solution, the most common of which is salt, but nearly all minerals, includnig gold, are present. Salt is present in sufficient amount to give the water its characteristic taste. All running water in lakes and rivers contains some salt, which is one of the most widely distributed minerals that we have, carrying it into the ocean, whither all the fresh water on the globe tends, it evaporates and leaves the salt behind, so in the course of ages the entire body of water has become salt, and the saltiness must continue to increase as the ages pass. Owing to the presence of the minerals in solution, the density of salt water is a trifle more than fresh water, which is the same as saying it will hold a body on its surface heavier than will float in fresh water.

RELATIVE POSITIONS OF LAND AND WATER.

The bottom of the ocean partakes of the same motions as the crust of the earth in general; that is to say, it also rises and falls the same as the surface of the continents, and hence, as the water always seeks the lowest levels, the relative position of land and water has varied greatly during different geological ages, so much so, that except some great mountain sections, all that is at present the fertile plains, plateaus, prairies, and river valleys of the world have at different times been at the bottom of the ocean, and doubtless vast sections now forming the ocean bed have been fertile areas of dry land in the past.

AMOUNT OF WATER.

It is thought by some of our scholars that ages ago the total volume of water on the surface of the earth was much larger than it is now, and that the supply will further shrink as the ages pass; in short, that the life history of a planet like the earth is a history of progressive desiccation, and those holding these views point to conditions on the planet Mars as corroboration of the same, believing that we can plainly see on its surface the beds of oceans, long since dried up.

THE CIRCULATION OF WATER.

There is a circulation of water on the earth strangely analogous to the circulation of blood in man. The sun constantly evaporates thousands of tons of water from the ocean which, as water vapor, is wafted by the winds to the most distant and diverse sections of the earth. There it is precipitated to the surface in the form of dew, frost, snow, hail or rain, which gather in rivers and lakes and so journeys again to the ocean from which it came, but carrying with it salt and other minerals it has come in contact with and dissolved in its journey, and immense quantities of soil it has washed into the rivers and thus transported to the ocean.

It will be seen on reflection that this circulation of water constitutes the great erosive force of nature, since it constantly tends to wear down the surface of mountains, elevated plateaus and plains and scatter the materials over the ocean floor, the latter to be elevated again by the upheaving power of the earth's internal heat; and we can add that this same force also is constantly interfering with the leveling erosion of water. In this way, it is shown that the general surface features of the country are being constantly worked over in the long course of ages. But the action of water in its ceaseless round to and from its ocean home will triumph in the end, and in an old and decrepit planet like Mars, there are no longer towering mountain ranges, no vast elevated plateaus much exceeding the general level of the surface.

FACTS ABOUT EARTHQUAKES.

Earthquake is a very expressive term for a phenomenon with which all are familiar, some by personal experience, others from general description in books and papers, for when destructive earthquakes take place, life and property loss is so great that the whole world takes notice. Our scholars are agreed that the cause of earthquakes is deep seated within the earth's interior. Like volcanoes, they are evidence of internal activity.

We now understand that the earth was once a glowing star, a miniature sun; it might or might not have been in a gaseous state, as the sun is now, but it was in an excessively hot condition. Much of it, at any rate, was in a molten condition, and the limited surface of our great volcano, Kilauea in the Sandwich Islands, is, on an extremely small scale, a modern representative of the ancient appearance of the surface of the earth for immensely extended periods of time. But in process of time the surface became crusted over, and the skeleton outlines of our present continents began to appear. In the long course of ages this crust has covered the earth generally. It is of unknown thickness, not necessarily uniform, and it covers vast reservoirs of molten lava, not necessarily connected or including all or even the greater parts of the interior. On the sunken parts of this crust the waters have gathered, forming our oceans. The crust is in a state of unstable equlibrium. It is rising and falling, to conform to the shifting volume of molten matter on which such large parts of it rest. For countless reasons, the crust is rising in places, falling in others. Fortunately, these movements now and for ages past, have been very slow, vast sections rising a few feet or even inches a century. In sections this movement is doubtless more rapid than in others, and in some eras, more pronounced than others. It must have been more active in early ages. This movement of the crust produces in places giant wrinkles, which we recognize as mountain ranges, but they are as truly wrinkles as those of the skin of an apple when it becomes dry and withered. All such motion produces heat. The many million tons of matter in motion inevitably produce friction and heat, and along some lines of least resistance volcanoes appear, which are vents for the imprisoned heat, through which sometimes bubble portions of the reservoir of molten matter, situated near the subsidence. Thus it is that around the Pacific Ocean are situated the great volcanoes of our present age.

But this motion is not always slow, and hardly noticeable. Nature delights in variety, and spasmodic movements often occur. These movements are known as earthquakes, which may be regarded as spasmodic movements, generally occurring in a relatively contracted area, the analogues of the slow and stately movements of emergence or subsidence of continental expanses. These movements are generally intimately related to the internal heat of the earth, and the behavior of great reservoirs of molten matter, and hence generally occur in volcanic areas, as around the Pacific ocean, including our own western coast section. But at other times, these earthquake movements seem to be simply a sudden rearrangement of the load, as if a portion of the solidified crust, perhaps extending over vast areas, had suddenly shifted position somewheres, which caused a more or less violent tremor, shiver or thrill to propagate itself from a center of disturbance, just exactly on the same principles that waves in water spread out from a disturbance in the pool.

In our own country, since it has been settled by white men, we have had the great earthquake of 1811, general throughout the Mississippi Valley; the Charleston earthquake of 1885, and the earthquake which destroyed San Francisco. In other lands, we have read of the great Lisbon earthquake, the Calabria earthquake, both in the 18th century, and of recent years, great earthquakes in Italy.

FACTS ABOUT THE SUN'S SPECTRUM.

In a beam of sunlight, there are united in a pencil of light, so to speak, seven differently colored rays that we can see or notice with the human eye. Color depends upon the rapidity of vibration, the red rays being far slower than the violet or the colors between, but one and all are of inconceivable rapidity as far as our senses are concerned. These being all united in one whole, produce the characteristic color of sunlight. But when refracted by a prism, these differently colored rays no longer travel in the same line, because refraction means to bend them out of the line in which they were traveling and they are not refracted to the same degree, for that also depends on the rapidity of vibration, consequently, what was at first a single pencil of light, becomes fanned out, so to speak, into a band of color in which the color red occupies one end, the violet the other, and the other colors between. That broadened, dispersed band of colored light is the sun's spectrum.

THE REAL SPECTRUM.

But the spectrum we see is only a small part of the real spectrum. The human eye is so constituted that it can take notice of, or cognize, only seven bands or bunches of vibrations, and these constitute the visible portion of the spectrum. Extending far beyond the violet end of the spectrum are other bands of vibrations. They are called the ultra (beyond) violet rays of the spectrum; and in this mysterious section are found the X-rays, and other rays which have many strange chemical powers. Some of these rays have received names, such as the Finsen and Roentgen rays, named after the person who first investigated them. Below the red end of the spectrum are other invisible rays. This portion of the spectrum is the infra (below the) red rays.

SPECTRUM ANALYSIS.

And now a far-reaching truth appears. Each chemical element emits rays of some one definite rate of vibration which when looked at through a spectroscope are always found (refracted to) in the same part of the sun's spectrum. If, then, a graduated scale be made and fitted to the sun's spectrum, and the location of the light from some substance—say common salt—be noted on that scale, we have a means of chemical analysis; for suppose we have some unknown substance, we examine the light from it through the spectrum and note the strong yellow band exactly in that part of the scale where the yellow glare of salt falls. We at once know that the element we are studying is salt, and so of other substances. It is understood these statements are general and crude. There are other substances which give yellow also, and in actual practice we need a very much dispersed spectrum compared by means of a very finely marked scale so as to determine beyond a doubt the exact location on the scale.

THE SPECTROSCOPE.

The careful study of the spectrum of the sun, and light from other stars, has yielded wonderful results and the spectroscope—the instrument by which we study the spectrum—becomes one of the most wonderful astronomical instruments ever invented. It unlocks the mysteries of the constitution—the elements composing the sun, nay, the most distant star in space, even of nebulæ, thousands of light years removed. More than that, by the shifting spectrum lines, the astronomer determines the rate of motion that stars are traveling, either to or from us in the line of sight. More wonderful still, is some cases, we know we are gazing at double stars so far removed that no telescope can see the individual stars, but the tell-tale spectrum lines form a record from which can be plainly read the mass of the component stars, the distances they are separated, the time of revolution around their common center of gravity, the relative brightness of the stars, and other details. All this and more can be read from the spectrum record as easily as from a printed page.

These wonderful results have come from a careful study of the outspread band of differently colored rays which, spread out by a spectroscope, constitute the sun's spectrum, or which, united in a pencil of light, constitute the dancing sunbeams of day. It is one of the strange alphabets with which nature records her secrets, waiting patiently for science to decipher them.

AURORA BOREALIS AND AUSTRALIS.

We are acquainted with the Aurora Borealis under the more common name of Northern Lights. In the southern hemisphere there is a similar phenomenon, which is known as Aurora Australis, or Southern Lights. It is a luminous appearance in the northern heavens, visible only at night. Sometimes it is simply a diffused glow, deepening in spots, in color some shade of orange or red. At other times, it is an irregular arch from which radiate streams of quivering light almost to the zenith; on rare occasions, it extends in an arch across the heavens from west to east. In high polar regions it is frequently a phenomenon of great beauty and interest. Sometimes it appears as if quivering, flimsy curtains of light were suspended from the heavens. We must remember that similar phenomena occur in southern latitudes, emanating from the south polar regions.

The phenomena in both cases are regarded as electrical in origin. The earth is a huge magnet, the poles of which are situated near the poles of the earth, and the lights are discharges of electricity in the rarefied atmosphere near the magnetic poles, just as in a nearly exhausted Geisslers tube the passage of an electric current produces waving ribbons of red and orange light near the electrodes of the tube.

We know that from the sun, floods of electrical energy are constantly emanating as well as light and heat—in essence doubtless all the same thing—and as all telegraphers know, there are electrical storms in our atmosphere. The auroral lights are the visible appearance of such storms near the poles of the great earth magnet. At times the telescope has caught glimpses of fearful electrical storms on the sun's surface, many times exceeding in volume and force the most powerful storms of earth, and at such times there is often a violent electrical storm in our atmosphere and generally brilliant auroral displays follow.

GRAVITATION.

Gravitation is the name of the force by virtue of which all bodies or particles of matter tend towards each other. That such a force exists is evident to all. It is a property common to all forms of matter, from the smallest mote to the largest orb. The apple attracts the earth as truly as the earth does the apple. In general, we can say that every particle of matter in the universe attracts every other particle. The attractive power of the earth is the force which holds us, the waters of the ocean, and all movable things to its surface. It is the attractive power of the sun which holds the earth in its orbit, all comets, planets, and meteorites in our solar system, from the least unto the greatest, obey the attractive power of the sun.

Being familiar with the operation of this force, we cease to consider its vast power. If we reflect on the enormous weight of the earth and the rapidity of its flight, we can form some slight estimate of the tremendous power wielded by the sun which, acting across the void of many millions of miles, securely holds the earth in its orbit. The ancients knew of this power, but it remained for Sir Isaac Newton to deduce the two simple laws of its action. The train of reflection ending with his great discovery is said to have originated by reasoning upon the falling apple in his garden. Once enumerated, they were seen to necessarily include the three great laws of planetary motion which Kepler had so laboriously worked out fifty years earlier.

The laws of gravitation afford a beautiful example of the universality of natural laws. Throughout the boundless realms of space they hold good. Double stars so remote that it takes thousands of years for their light to reach us, when investigated by the spectroscope, are found to obey the identical laws of motion that hold sway in our own solar system, such as we see in operation around us every day.

WHAT IS GRAVITATION?

The human intellect can not as yet tell us what gravitation is. It is another of the great mysteries before which we are dumb. We can not as yet form even a satisfactory hypothesis as to its nature. It obeys what is known as the law of least squares (inversely as the square of the distance) agreeing in this respect with sound, light and heat, but if it be any form of vibration—as they are—it is something entirely different from any vibration that we know, and its rapidity of propagation must be vastly greater than that of light, it must, in fact, be practically instantaneous over the greatest distance. But it is quite useless to attempt to explain gravitation with our present knowledge.

ETHER OF SPACE.

Ether is the name given to the supposed substance thought to fill all space. It is also the name given to an anesthetic; this fact sometimes causes confusion in ideas. Light, heat, and electricity come to us from the sun across vast distance, and light from the stars travels much farther. There must be something to transmit the vibrations whose effect we cognize as light. There seems to be a necessity for making such an assumption. Also, in the case of wireless telegraphy, some kind of wave action seems to circle out from the sending stations. The vibrations are evidently not those of air; they must be vibrations in some other medium. Since light comes to us from stars, vastly distant and from all directions in space, it is evident that whatever that medium may be, it is co-extensive with space. In other words, it is endless in extent. We cannot substantiate this statement, but if some of our astronomers be right in their estimate of the distance of the nebulæ in space, it is endless to human senses.

But recognizing the necessity for assuming the existence of something filling all space, at present we can in no way prove its existence, and all theories as to its nature are theories only. The most contradictory statements conceivable seem indicated by the transmission of such vibrations as these of light. They are so startling, so utterly self-contradicting, that we might as well confess we know nothing whatever about the ether. It is by no means the only mystery which surpasses us.

THE ZODIAC.

We all know that in winter the sun is apparently much farther south than in summer. This apparent path of the sun, indicated by the stars near his course, is called the Ecliptic. It is a great circle in the heavens inclined to the plane of the earth's equator. This motion is, however, only seeming, for the sun does not move relatively to the stars. The earth, however, is in motion around the sun, and causes the apparent motion of the latter, exactly the same as the revolution of the earth on its axis makes the sun appear to rise in the east and set in the west. But in the course of the year the sun apparently describes this circle in the sky.

SIGNS OF THE ZODIAC.

It takes twelve months to describe the circle, and so in extremely ancient times the primitive astronomers of the enlightened Egyptians, Babylonians and Hindoos arranged the stars scattered along the ecliptic, including those on each side of it, into fanciful animal shapes, one for each month of the year, and selected animals that were in a way appropriate to the month. Such fanciful forms assigned to groupings of stars are called constellations, and as each constellation along the ecliptic has an arbitrary sign, as a sort of shorthand character to designate it, the twelve constellations along the ecliptic are called the signs of the zodiac; the latter term means belt or girdle, it is a space eight degrees wide on each side of the ecliptic. We see in most cases the appropriateness of the name given to the constellation through which the sun apparently journeys. When the sun reaches the Tropic of Cancer, he apparently begins to retrace his course, hence for that month we have Cancer, the Crab, which goes backwards; when he reaches the Tropic of Capricorn, he commences to climb, hence we have Capricornus, the Goat, and so on for the other constellations. The names of the constellations have come down to us from very early times. They are Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Sagittarius, Capricornus, Aquarius and Pisces. Here, to give completeness to this account, it is necessary to remark that in the long course of time, since the constellations were named and the signs given them, the sign and the constellation have parted company and each constellation is now in that part of the zodiac originally designated by the sign of the constellation following it to the east. This divergence will increase as time passes, but in about 23,000 years from now they will once more be in agreement.

ORIGIN OF THE SIGNS.

The origin of the zodiacal signs is lost in prehistoric times. The Egyptians, Hindoos and Babylonians had zodiacal signs similar to but not identical with our present ones. Of course the animal forms are purely imaginary. The fact is, there is only one that can be forced into any sort of resemblance. We must not understand that the distant stars seen in projection against the vault of the heavens, apparently near together, are so in fact. They are separated by almost infinite distances from each other. Were we placed on one of them, we would see the others as shining stars in the distance. Some in the same sign may be many times farther removed from us than the others. Neither must we suppose that the signs of the zodiac have anything to do with the character or life of the individuals born when the sun happens to be apparently in that constellation. Astrology, casting the horoscope, in other words, determining the position of the planets and sun at the moment of birth in reference to signs of the zodiac and thereby foretelling the future, belongs to a fanciful science of the long ago, for which modern learning can find no foundation in fact.

THREE FORMS OF CARBON.

Carbon is one of the most widely distributed elements. It is present as an important constituent in nearly all stars.

One great point of interest about carbon is the three forms in which it exists in a pure state. The first is finely powdered carbon, said to be in an amorphus state, that is, without form. It does not occur this way naturally, but is produced in several ways, as by burning and powdering charcoal, as soot in chimneys, lamp black, etc.

GRAPHITE.

Graphite is a form of pure carbon, thus identical with charcoal, though it differs greatly in appearance. It occurs as a mineral in various rock formations, and is known also as plumbago, and blacklead, though there is no lead about it. It is a very important product, and used for many purposes. In its nearly pure form it is used to make lead pencils. Impure graphite is used for stove polish, foundry facings, crucibles, and in electro-plating. It is a good conductor of electricity and thus assists in the deposit of the gold, silver, or copper that is being used to furnish the coating. It is obtained from mines in Ceylon, Siberia and New York. The principal graphite supply for lead pencils manufactured in the United States is Mexico.

DIAMONDS.

Strange as it may seem, diamonds are nothing but crystallized carbon. Chemically the diamond, the hardest of known substances, and lampblack, almost the softest, are identically the same. The diamond is the most valuable, the most interesting of all minerals. As its specific gravity is high—three and a half—the carbon atoms must be closely packed. It is the hardest of all known metals; there is nothing it will not scratch. Its refractive powers are high, that is, it splits a pencil of light into a broad spectrum, hence the secret of its flashing appearance, when exposed to light. One of the greatest points of interest about diamonds is the secret of their formation, which nature guards so well. Evidently, intense heat and crystallization under great pressure are needed. In the great diamond mines of South Africa the diamonds are found in the blue mud filled volcanic pipes of extinct volcanoes. The blue mud is decomposed Olivene rock, forced up from deep in the interior of the earth, but the diamonds found in it have been broken off from some other formation, far beneath the surface.

DIAMONDS IN METEORITES.

In the masses of meteoric iron—that is, portions of aerolites picked up here and there on the surface of the earth—microscopic diamonds are sometimes noticed. Their presence is eloquent testimony to most interesting bits of evidence as to the formation of the aerolite. Manifestly, it is but a fragment of an exploded world. What was the nature of the catastrophe which scattered the aerolites in space? But their presence in the iron has proved an incentive to efforts for the artificial production of diamonds. Whoever will invent some cheap process for the manufacture of genuine diamonds will have a fortune in his grasp. Some years ago Prof. Moisson of Paris, by melting iron heavily charged with charcoal, and cooling it suddenly in mercury, succeeded in obtaining microscopic diamonds. Later, M. E. de Boismenu, also of Paris, has produced small diamonds by an electric furnace method, some of which were one-tenth of an inch in diameter, and one was large enough to be cut. Thus far the process has been a very expensive one, but improvements are bound to come, and we may soon learn how to produce by artificial means the crystallized forms of carbon known as diamonds.

COMPRESSED AIR ENGINES.

One of the uses of compressed air is to drive machinery in locations where steam cannot be utilized. One of the first applications of this principle was in the excavation of tunnels, such as the Mount Cenis Tunnel. In such cases the air not only drives the drill used in boring into the rock, but escaping into the tunnel, its value for breathing purposes is not lessened. It has also been used in coal mines, but electricity is taking its place in such mines. In excavating the great Culebra Cut (now known as the Gaillard Cut) on the Panama Canal, the many batteries of drills that preceded the steam shovels were driven by compressed air, which was supplied to them from large main tubes on the surface of the cut into which the air was compressed by engines situated at various points.

Air engines themselves do not differ in principle from steam engines. The elasticity of compressed air is the motive power in the air engine, used exactly as confined steam is used in the steam engine. Whether you have in mind air engines, steam engines, or electric motors, the first source of the energy which drives them is obtained from the combustion of coal or water power. In the use of compressed air in any form, the air has first of all to be compressed, and the compressor itself is the prime motor. On submarines, the compressed air is stored up in great reservoirs and used to drive the engines of the submarine when it is running submerged. The same engines run by gasoline when on the surface are run by compressed air beneath the surface. The air brakes on railroad trains are released by compressed air, the compressor being run by the locomotive. The torpedo fired by the submarines is driven through the water by propellers operated by compressed air stored up in the body of the torpedo.

FACTS ABOUT THE MAGNET.

A substance which has the power of attracting iron, nickel, cobalt, silver, and a few other substances, is called a magnet. Some forms of iron ore are natural magnets. They were formerly called load-stones, but are now properly named magnetite. This form of iron ore is very valuable, for it produces a superior kind of iron. It was formerly of limited amount in the United States, but only recently immense deposits, aggregating hundreds of millions of tons, were discovered in the Cuyuna range, one hundred miles west of Duluth.

TWO CLASSES OF MAGNETS.

All of the magnets used in science or the arts are artificial magnets. There are two ways of producing them, and different forms of iron retain magnetic power for very different periods of time. Some—soft iron—lose the property at once, when the electric current ceases to flow; such magnets are called electro-magnets. Others—steel and hard iron—retain it for a very long time, and are called permanent magnets. If a bar of iron be wrapped with fine wire through which a current of electricity is sent, it becomes a magnet. Or if a piece of iron be merely rubbed with another magnet, it becomes one. There are always two poles to a magnet, situated at the extremities, being the points where the greatest effect is produced. They are known respectively as the north and the south pole. The north pole is that pole in a magnet which, if it be free to move around a vertical axle, will point towards the north pole of the earth.

The more scientific name for these poles is positive and negative. Midway between the poles in a bar magnet is a point where the magnetism is neither positive nor negative. This is called the neutral ground. Another property of the magnet is this: from the poles of a bar magnet, lines of force (not knowing what else to call them) shoot out and bend back towards the neutral center. The space cut by those lines is known as the magnetic field of the magnet. When a delicate needle, suspended by a thread attached to its middle point, is placed near a bar magnet, it will arrange itself parallel to the lines of force.

THE EARTH A MAGNET.

The earth itself is an immense magnet with its north and south magnetic poles near its geographical poles. However, it should be stated that the location of these poles is not constant. For some obscure cause they vary in position, describing irregular curves. These variations are daily, seasonal, and secular, that is, extending over a number of years. The fact that the earth is a magnet explains the action of a compas needle. It points north and south because it arranges itself parallel to the lines of force of the earth's magnetism.

However, the needle partakes of all the variations of the magnetic pole, consequently it by no means always points to the geographical north. So that the navigator not only must have tables of these variations but he must make constant observation of the sun by day and the stars by night to determine his true position. Shipwrecks have been occasioned by error in the compasses of very small amounts, but if unnoticed that error in the course of a hundred miles will throw the ship some distance out of its course and may head it upon some dangerous shoal or rocky ledge. It is considered so important to understand the compass variations in different parts of the earth, that only recently the Carnegie Institute had a non-magnetic ship built—that is, a ship in which bronze bolts, etc., was the only metal used—and with this ship caused a magnetic survey of the earth to be made.

EXPLANATION OF MAGNETISM.

We cannot explain magnetism any more than we can gravitation. It exists and we understand some of the laws of its operation, but what it is, or the explanation of its influence, we do not know. We also know that it is a molecular force, that is to say, that each molecule in a magnet is itself a magnet. Hence we can break or divide a magnet into as many pieces as we wish; each particle will still be a magnet with a north and south pole. Every telegraph instrument utilizes an electro-magnet, and in countless ways we make use of them. Magnets of great power are used to draw out pieces of steel imbedded in the eye.

FACTS ABOUT ELECTROPLATING.

Much so-called silver or gold plate is some common metal, steel or nickel, coated with a thin layer of silver or gold. The cases of most gold watches are of this nature. The copper surface of most of the plates from which books and illustrations are printed is deposited on lead or type metal bases. The process of thus coating the surface of one metal with a thin layer of another is known as electroplating. It depends upon the property of electricity known as electrolysis, that is, the decomposition, disintegration, or splitting up of chemical molecules, setting free the atoms of the elements united to form the compound. Water, for instance, is a chemical union of oxygen and hydrogen. If, now, water in some suitable vessel be rendered slightly sour by the addition of sulphuric acid, and a current of electricity be passed through it by means of electrodes on opposite sides of the vessel, the passage of the current decomposes the molecules of water, setting free the atoms of hydrogen and oxygen which, unless confined, will escape into the atmosphere. Many substances can thus be decomposed, but the disengaged atoms, not being gaseous, do not pass out of the water, but are ready to deposit themselves on a suitably prepared surface—say of another metal—and do this in such a uniform way that every exposed portion of the metal will receive exactly the same amount of covering in the same length of time.

In practical operations, as if we wish to electroplate spoons and other articles of tableware with silver, plates or pieces of silver are suspended in a suitable vat filled with water. These silver pieces form the negative electrode. The articles to be silvered form the positive electrode; such articles are also suspended in the vat by copper wires from brass rods. The current is turned on and at once electrolysis begins and the atoms of silver, set free, commence to deposit themselves on the spoons, mugs, vases or whatever the suspended articles may be. When they have been given a coat of silver of sufficient thickness, they are removed, cleaned, burnished and are ready for the market, and only an expert can detect that they are not solid silver.

ELECTROTYPING.

Electrotyping is simply a special branch of electroplating. It is the process of preparing solid copper covered plates similar to the one from which this page is printed. The page was first set up in printers' type, then a wax mold was taken of the face of that page. That wax mold was the base on which a thin layer of copper was deposited by the proces of electroplating. When that copper shell was removed from the wax mold we had a copper mold in its stead, an exact reproduction of the face of the type, with the i's dotted, the t's crossed, the commas in place. That thin copper mold was then backed up, or filled in the back with type metal to form a solid, unyielding plate, and from it this page was printed.

FACTS ABOUT ETCHING.

Etching is a very interesting and important process, since it is used in some form to produce nearly all the plates from which are printed the illustrations, designs, drawings used in papers and books. To etch means, literally, to eat. It is the process by which we eat, or bite, or cut the outlines of whatever design or figure we wish to reproduce on a metallic plate—as copper, steel, zinc, etc., by means of some chemical agent as nitric acid. Let us suppose we wish to make a zinc etching. The plate is carefully cleansed and then covered with what is known as etching ground generally comprised of Egyptian Asphaltum, beeswax, and Burgundian pitch. This covering, very thin and uniform in thickness, is allowed to dry. The design may be drawn on this ground by an artist, but generally it is photographed on it. An expert workman now takes it in hand, and with his tools, the principal of which are the etching needles, he carefully cuts out these lines in the ground. That is, he removes the wax, leaving the outline exposed on the zinc. Now a little bank of wax is built up around the edges of the plate and a weak solution of nitric acid is poured on it, which at once begins to eat out the lines of the design. Some lines may be desired deeper and stronger than others, and so, when sufficient time has elapsed to etch the faint lines, they are covered with varnish and the deeper lines allowed to remain exposed to the action of the acid. When the etching is completed the plate is carefully cleaned. There is present on it the incised—cut in—outlines of the design wanted; from that an electrotype is made and printed as usual.

HALF-TONES.

Etching in some form is part of the work in all "process" plates, the principal and most important of which is the half-tone, which is the process employed in making most of the illustrations in this book. The first step consists in making a negative of the photograph which we wish to reproduce. The negative is taken in a camera through a specially prepared screen. This screen consist of two plates of very finely ruled glass. The lines are ruled diagonally on the glass, and in number range from about a hundred to two hundred per inch. The finer the screens, the finer the plate. Two of these plates are used, cemented together by Canada balsam, and so arranged that they form numerous minute diamond-shaped checks. On the negative these small checks will appear as lines of dots, varying in light or dark color just in proportion to the shades on the picture. That negative is used to photograph the picture on a plate covered with a thin, sensitized varnish which hardens under the influence of light. It is evident, then, that we will have on the wax a reproduction of the photograph in which all the varying shades of light or dark are impressed on the sensitized film, which is dissolvable just in proportion to the light that has fallen upon it. The plate is now etched, and we have a mold on the plate which reproduces the original photograph with its varying shades of color.

HORSE-POWER.

The term horse-power is supposed to mean the power that an average horse can put forth. When the steam engine was first invented it was quite natural that men should state its power, or ability to perform work, as equal to that of a certain number of horses, as say, fifty horses. But that term is so very indefinite as to be of no value since one horse might be twice as strong as another, and so an arbitrary value was assigned to it. It is the force that will move 33,000 pounds one foot in one minute. It is, of course, necessary to employ calculation in determining the horse-power of an engine. The average pressure of the steam as shown by the gauge, the area of the piston, the stroke and number of strokes per minute are all considered. The actual power or effective power is only seven-tenths of the indicated power. The rule is to multiply the area of the piston, expressed in square inches, by the pressure per square inch, and that product by the rapidity in feet of the piston per minute; divide the final product by 33,000 and then take seven-tenths of the quotient. Estimating the horse-power of steam turbines, electric motors, falling water and other forms of energy producing machines is, of course, a complicated process. It is not, however, guesswork, but carefully calculated, and the term itself always means the arbitrary value given above.

GUNPOWDER.

Gunpowder consists of an intimate mixture of saltpeter, charcoal and sulphur, which forms an explosive compound used in gunnery, mining, blasting, and so forth. Formerly the armies and navies of the world depended on gunpowder as their explosive, but smokeless powder and various high explosives have taken its place. But it is still used for many purposes. The explosive power is due to the fact that it contains sufficient oxygen for union with the nitrate, and carbon to set free enormous volumes of gas, occupying from 1,000 to 1500 times the space occupied by the powder. As manufactured it exists in grains of different sizes and forms, according to the kind of gun in which it is to be used, the purposes for which it is employed, etc.

HISTORY OF GUNPOWDER.

It is generally believed that the Chinese were the first to use gunpowder, but we know nothing for certainty about the matter. The Hindoos also claim it. Doubtless, gunpowder, especially its use in warfare, was not the work of any one man or nation, but was the result of a great many different steps leading up to the completed product and its various uses taken by different people at different times and places. All we are certain of is that early in the 14th century its use in warfare was well known in Europe.

Cannons were used in the important battle of Crecy in 1346. Probably many fragmentary and scattered notices in early histories which some think refer to the use of powder, consequently cannons, really have reference to some chemical like Greek fire. Smokeless powder, so much used at present, is an altogether different explosive. Guncotton, that is, cotton soaked in a mixture of sulphuric and nitric acids, is the principal ingredient in such products.

DYNAMITE.

Dynamite is an explosive much used in mining, tunnel excavation, quarrying, etc., invented by Alfred Nobel in 1866. In general, dynamite is some porous material which has absorbed nitro-glycerine. The absorbent materials used are of two general classes. In the first group are those which are inert in themselves, that is, do not help with an explosive power of their own, such as sawdust, charcoal or infusorial earth. Nitro-glycerine itself is a very unstable explosive and must be handled with extreme care, but when the liquid nitro-glycerine is absorbed by the porous substance, just as water is absorbed by blotting paper, and allowed to dry, the material used is loaded with nitro-glycerine, but it is now much safer to handle and it still has about eight times the explosive power of gunpowder. Its appearance in this form is that of a greyish-brown, reddish or blackish powder —according to the absorbent used—damp and greasy to the touch and without smell. The absorbent may, however, be some substance such as a nitrate, which contributes to the resulting explosion by powers of its own. The most explosive of this form of dynamite is known as the gelatine dynamite. For commercial purposes it is made up into sticks or cartridges eight inches long, about one and a half inches in diameter, packed in boxes of sawdust, each box weighing fifty pounds.

HOW CELLULOID IS MADE.

Briefly defined, celluloid is a species of solidified collodion produced by dissolving gun cotton (pyroxylin) in camphor with the aid of heat and pressure.

GRINDING GUN COTTON.

The gun cotton is ground in water to a fine pulp in a machine similar to that used in grinding paper pulp. The pulp is then subjected to powerful pressure in a perforated vessel to extract the bulk of the moisture, but still leaving it slightly moist for the next operation. This consists in thoroughly incorporating finely comminuted gum camphor with the moist gun cotton pulp. With this mixture any coloring matters required can now be employed.

SUBJECTED TO POWERFUL PRESSURE.

The next step is to subject the mass to powerful pressure in order to expel from it the remaining traces of moisture, and incidentally to effect also the more intimate contact of the camphor with the pulp. The dried and compressed mass is next placed in a mold, open at the top, into which fits a solid plunger. A heavy hydraulic pressure is brought to bear upon the plunger, and at the same time the mixture is heated by means of a steam jacket surrounding the vessel to a temperature of about 300 degrees Fahrenheit. When the mass is taken out of the press it hardens, and so acquires the extraordinary toughness and elasticity which are the distinguishing characteristics of this remarkable production.

A SUBSTITUTE FOR IVORY AND PORCELAIN.

Celluloid is very largely useful as a substitute for ivory, which is imitated with great success. Tortoise shell, malachite, mother of pearl, coral and other costly and elegant materials are also so successfully imitated that an expert can hardly detect the original from the copy.

Celluloid is also used as a substitute for porcelain in the manufacture of dolls, which will stand a good deal of rough usage without breaking. Combined with linen it is used for shirt bosoms, cuffs and collars.

DAGUERREOTYPE.

The daguerrotype is of interest as being the first step in photography, or rather the first successful process which has led up to the wonderful photography of the present. Like the first beginnings of everything, the process now seems crude, but it was a wonderful invention. It was invented by M. Daguerre of Paris, perfected in 1839. He was a scene painter and had long been studying the problem of fixing the images of persons on suitable prepared paper. The means he employed were a silver plate, or a copper plate, covered by a thin layer of silver. This was sensitized by vapor of iodine, then placed in a camera obscura previously focussed. The latent image was then developed by the vapor of mercury, and fixed by immersion in hyposulphate of sodium. This invention was deemed of such importance by the French government that M. Daguerre was awarded a pension of $1,200 for life. Considering the wonderful development of photography at the present and its great use in the sciences and arts, especially in astronomy, it was indeed one of the most important inventions ever made.

GALVANIZED IRON.

Galvanized iron is iron coated with zinc. The result is similar to that produced by electroplating, but the method used is much simpler, because molten zinc has an attraction for iron. The name "galvanized iron" is therefore not appropriate, but it has been sanctioned by long usage. Sometimes the sheet of iron is first electroplated with a thin coating of tin, but ordinarily it is merely cleaned with acid to remove scales and then immersed in a bath of molten zinc, when the latter at once begins to deposit itself on the iron. The advantages are that we have a sheet of iron whose surface is not affected by atmospheric moistures, and so does not rust. However, water will dissolve minute quantities of zinc, which action of course is increased by heat, consequently utensils made of galvanized iron cannot be used for cooking purposes, as the zinc is poisonous.

INDIAN SUMMER.

Indian Summer is a season of pleasant weather which usually comes in October or November, rarely in December, and may last for two or three weeks. It is characterized by the presence of cloudless skies, calm or light winds, hazy atmosphere and mild temperature. It is not peculiar to the United States. In Germany it is known as the Old Woman's Summer, in England as St. Martin's Summer. It is known to occur in China also. A change in the upper strata of the atmosphere, confining the radiating heat-rays to the lower strata, is generally held to be the true explanation for it. Balloon ascensions at such times find very little movement in the upper atmosphere. The air is generally smoky or hazy. On Western prairies the fires generally visible at such times were thought to account for this appearance, but since the same phenomena occurs in other countries, that cannot be the true explanation.

MEERSCHAUM.

Meerschaum is so commonly used to make a superior kind of tobacco pipe that it is one of the definitions given. Properly, however, it means the mineral from which such pipes are made. People not well informed in the localities where it is produced think it is petrified sea foam, the literal meaning of its name. It occurs in Moravia, Spain and Asia Minor. It is mined just as other minerals are, in pits and galleries at a depth of about 25 feet. When first mined it is so soft that it can be readily cut with a knife. It will even lather in water and remove grease, like soap, and is used by those who mine it as a natural soap. In appearance it is greyish-white with a faint yellowish or reddish tint. Scientifically, the metal is described as hydrated magnesium silicate.

HELIOGRAPH.

The heliograph is an instrument used for transmission of signals between distant stations by reflecting the sun's ray from a mirror or a system of mirrors. The principal was understood centuries ago, but has only been practically applied in very recent decades. The flashes of light are made to appear at distant stations in long flashes or short ones, corresponding to the dots and dashes of the Morse alphabet, and so can be read. The distance across which it is possible to thus flash messages depends primarily upon the sunlight and the state of the atmosphere, and also on the size of the mirrors used. They must be sent by one instrument and received by another. In the United States army experiments messages have been sent, in the clear atmosphere of Arizona, 215 miles. This principle is used in coast survey work, where the angular distance of mountain peaks is desired. For that purpose it is very effective.

HOW HEAT IS MEASURED.

We desire to have some means of knowing how much hotter one body is than another, in other words, we need something to measure heat. All such instruments are thermometers. In most thermometers we measure the degree of heat by the contracttion or expansion of a liquid or gas. The common form consists of a glass tube of very small diameter, sealed at its upper end, the lower end terminating in a glass bulb in which is contained mercury or alcohol which indicates the degree of heat to which it is exposed by the space it occupies shown by the position of the top of the column on a graduated scale. The hotter the temperature, the greater the expansion of the liquid contained, and the higher the column rises in the tubes.

We must make choice between two natural stages of heat and divide the distance between them into some number of equal parts which we shall call degrees. Water is chosen as the substance. The temperatures of the freezing point—under normal conditions at sea level and pressure—is assumed as the starting point; the temperature of the boiling point of water, subject to the same conditions of pressure, is taken as the other extreme. Now, the distance between these two points is arbitrarily divided, on the Fahrenheit scale into 180 degrees, on the Centigrade scale into 100, on the Reaumur or Swedish scale into 80 degrees. The most common popular thermometer is the Fahrenheit, that has still another peculiarity. Fahrenheit found that when melting ice by salt he obtained a still lower temperature than freezing water, in fact it was 32 of his 180 degrees between the freezing and boiling points of water. He took that temperature as zero and his thermometer shows the freezing point at 32 degrees and the boiling point at 212 degrees. The Centigrade thermometer is the most scientific of the three forms and is the one used in scientific experiments.

GAS THERMOMETER.

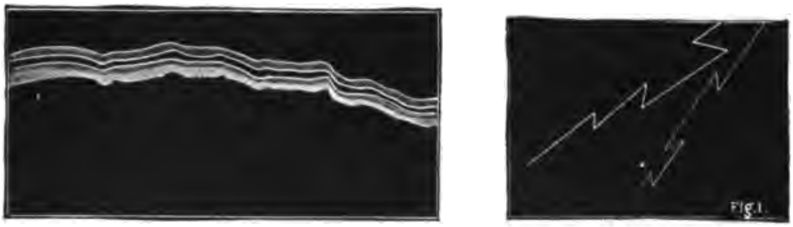
The gas thermometer consists of a volume of gas suitably confined so that its change of volume at constant pressure can be noted. Such a thermometer with hydrogen as the gas, measured on the Centigrade scale, is the standard thermometer with which other thermometers are compared. Still other forms of thermometers are necessary to measure very high temperature, or very feeble ones, or very delicate changes. Nearly always some form of electrical thermometers is employed, the basic principles being that a change in temperature produces a difference in the passage of an electrical current, which rate of difference can be measured by a galvanometer. Thermometers are a necessary part in almost all scientific experiments, and in the Bureau of Standards at Washington the government has instruments so delicate that the mere presence of a person some yards away affects them.

RAINBOW.

Everyone is familiar with the beautiful arc of colored light, sometimes almost a semicircle in shape, visible when the sun is shining while rain is falling. Each drop of rain acts as a prism and splits the white beam of sunlight into its seven principal colors which will be reflected and refracted and travel away from the drop, not as a single pencil of light as they were when they struck it, but as a ribbon of light. From some drops situated at the right position in space relative to the sun and our eyes, we catch the red color, and other colors of the spectrum from still other drops, or from the same drop as it changes its position while falling. All drops in the same relative angular position are going to send the same colored rays. But drops so situated with respect to the eye and the sun, when seen in projection against the clouds, will always form a segment of a circle, and since the angle of emergence of the rays from the drop must be equal to the angle of incidence, it will always be in that part of the sky opposite to the sun. Since the red is refracted the most it will be seen on the outside of the bow.

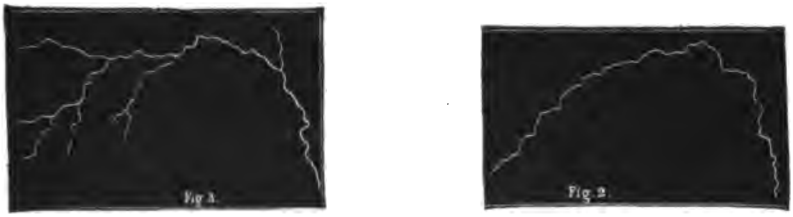
THE SECONDARY BOW.

There is often seen another, larger bow, concentric with and near the first bow, known as the secondary bow. Its formation differs from that of the primary bow in that there are two internal reflections; it is much fainter and has the red on the inner edge of the bow. On very bright moonlight nights the moon sometimes gives rise to a rainbow, explained exactly the same way, but it is faint and the colors not clear. In the spray of fountains, waterfalls, geysers, escaping steam generally, we sometimes catch glimpses of fleeting rainbows. It is interesting to reflect that no two ever see the same rainbow. It is not a band of color in the sky like a gigantic painted sign, but simply rays of vibration that strike the eye that happens to be in their line of flight.



Wave shaped.

Zig-zag.



Ramified.

Sinuous.

FORMS OF LIGHTNING.

LIGHTNING.

Lightning is one of the ways in which the electricity, always present in the atmosphere, is at times visible to us, and also at times manifests its destructive power. Electricity comes to us from the sun, and in fact is of the same nature as light itself. Currents of electricity are therefore everywhere in evidence. The northern lights, also the southern lights, are evidence of its presence. Often there are electrical storms in the atmosphere, not evident to ordinary observation, but electrical conditions are so disturbed that telegraph instruments do not work and compasses are out of adjustment. It is therefore not strange that different layers or bodies of clouds become very differently charged with electricity, or that the earth and the clouds should become differently charged. And we understand why during the summer when currents of heated air are more vigorous such conditions should be intensified.

When the electrical strain is sufficiently powerful there is a sudden passage of electricity from cloud to cloud or from earth to cloud—or the reverse—which equalizes the strain. The passage of that electrical current gives rise to the phenomena of lightning and thunder, and we say we are having a thunder storm.

The lightning is the flash that accompanies the electrical discharge. In our laboratory experiments we produce small flashes a few inches or feet in extent. Lightning is nature's flash on a gigantic scale—sometimes miles in extent. Photographs have been caught of lightning flashes and we learn their different kinds as wave shaped, zig-zag, ramified and sinuous. When the passage is from clouds to the earth, or the reverse, great damage is sometimes occasioned. Trees, houses, animals and men are sometimes struck. This is because the electrical current always takes the line of least resistance, in other words, the best conductors. The last three forms of lightning show the varying resistance met in the passage of different strata of air. In the wave form we see several discharges—all needing only a small part of a second in time—following the same track, the first flash having beaten a path, so to speak.

THUNDER.

As all know, the lightning flash is generally followed by a clap of thunder; it is simply a loud noise and does not of itself cause any damage. Sound is the effect on the ear of air vibrations. The passage of the electric current—always meeting with resistance in the air—intensely heats it and causes a sudden rarefaction that occasions a momentary partial vacuum and the air rushing in is thrown into violent vibrations, which, reaching the ear, are cognized as thunder. The vibrations of air travel at an immensely slower rate than those of light, so that about five seconds between the flash and the time we hear the thunder lapses for each mile of distance. When this is considerable, the sound becomes rolling, due in part to reflection of the air waves from the ground, buildings, clouds, etc.

TERMS USED IN ELECTRICITY.

Though no one can tell what electricity is, we do know some of the laws of its action, and we are able to employ it in the arts and sciences. It is such an important factor in modern life that a great many technical terms are used by those familiar with it to express their meaning. It is not necessary for us to be electricians to understand these terms, but a knowledge of their meaning enables us to understand much that we may read concerning the uses of electricity. While the old theory of electricity as a fluid is now abandoned, it acts so like a fluid that we constantly talk about it as a current of electricity, and it is helpful for us while trying to gain an understanding of the terms to keep the above idea in mind.

The current in its flow meets with resistance, just as water in a pipe. We measure that resistance by the ohm. One ohm is the resistance offered by a carefully defined column of mercury at the temperature of freezing water. Water through a pipe flows at a certain velocity, or if it be used in turning a wheel, we say it does a certain amount of work. Now, a current of electricity, which is strong enough when passed through a standard solution of nitrate of silver in water to deposit a certain small but definite amount of silver per second, is said to be one ampere. The ampere, then, is a measure of the flow of the current. From these two terms we determine still a third unit. Water in a pipe flows under certain pressure known as its head, depending on the height of the column. The electric current flows under pressure also, that pressure is the voltage of the current. One volt is a pressure sufficient when acting through one ohm of resistance to do one ampere of work. Still another measure of capacity is used. We wish to state the amount of electricity transferred. A coulomb is the amount of electricity transferred by a current of one ampere velocity in one second.

There are two other terms comparatively but little used, but it is interesting to understand them. We can store up electricity in condensers. The amount thus stored is measured in farads. A farad is a condenser of such a capacity that one coulomb of electricity produces a difference in potential of one volt. We know that an electric current in one circuit induces a corresponding current in a neighboring circuit. The electromotive force thus induced is measured in henrys. One henry is the amount of force induced by a current varying at the rate of one ampere per second. Most of these terms are commemorative of scholars who have distinguished themselves in electrical research, as Prof. Henry and Prof. Farady. Having thus used the old idea of a current to help us understand the terms used, we must now dismiss it from mind and wait for our scholars to give us a better understanding of what electricity is.

We also need terms to describe the mechanical equivalent of the work or energy which an electrical current performs. A joule is the mechanical equivalent of a volt, which, remember, is the pressure sufficient to send one ampere of electricity through one ohm of resistance; the amount of energy such a current develops is a joule. It is nearly one-fourth of a small caloric. The amount of work done by one joule per second is a watt. In practical usage the word kilo, meaning 1,000, is generally prefixed to some of these terms, as a kilo-volt, kilo-joule and kilo-watt, meaning 1,000 watts, etc. A kilo-watt is equivalent to about one and a third horsepower; a kilo-watt hour means the amount of work a kilo-watt can do in one hour.

GYROSCOPE.

We all know that a top if set spinning will remain upright as long as its rotation continues. That result follows because any body set in motion around its principal axis of inertia continues to revolve around it in the same plane, unless some outside force is used to change it, and it will resist the action of such an outward force with a force depending upon its weight and rapidity of rotation. Suppose, then, we have a wheel a few inches or a few feet in diameter—a bicycle wheel might be used to illustrate it—and set revolving around an axis, perpendicular to the plane of the wheel. It continues to revolve in that plane, if it be free to move, no matter if the mechanism be variously inclined, therefore if that axis be supported by a metallic ring and the whole apparatus given gimbal bearings (like the box of a compass) just as long as the wheel continues to revolve, it will maintain its position—pointing in the same direction, tipping its supporting frame up or down to keep in the plane in which it started. Now let us make another supposition: Suppose the frame instead of gimbal mountings were firmly fixed on a table and we tilt the table or stand, so as to shift the plane of rotation, the gyroscope resists, with what force it is capable, such a change, and if it be heavy and revolved with considerable speed, we would find it required a great deal of force to tilt the table.

This is the principle employed in maintaining the upright position of the Brennan Monorail Car as we have described it. Powerful gyroscopes, revolved at great rapidity by electric motors, resist any tipping action of the car, which would change their plane of rotation. This is also the principle employed in gyroscopic stabilizers on aeroplanes that we have noticed.

These are practical applications of the gyroscope on a workable scale. The gyroscope with which we are most familiar is the toy one, in which the revolving wheel is only an inch or so in diameter, set revolving around its axis by pulling a string previously wound around it. That little wheel revolves in its plane, around its axis. Suppose only one end of the axis be supported on a table, or held up by a string, a new movement begins; the little toy commences to move around a line perpendicular to the line of support no matter what angle it was lifted up, provided it be not too far from the center of gravity.

This follows from a law of motion, namely: Any motion of a body which has one point fixed is of the nature of a rotation about an axis passing through that point. Nature knows no great or small. The earth revolving on its axis, inclined to the plane of its motion around the sun, known as the plane of the ecliptic, is in reality a spinning top of gigantic proportions. The axis moves in a circle and this gives rise to the phenomenon of the precession of the equinoxes.

FACTS ABOUT SOUND

Sound is a sensation usually having its source in a body set in vibration from which waves pass by means of an intervening elastic medium to the ear, and by the mechanism of the inner ear, stimulate the auditory nerve. The transmitting medium is generally air; it may be other substances, as water, just so the vibrations get to the ear. In a vacuum, where there is no air, a bell may be made to ring, but we will hear no sound since there is nothing to carry the vibrations to the ear.

It takes time for the vibrations to travel from a distant source to the ear. In dry air at a temperature of freezing it is about 1,087 feet per second. The rate of travel is much faster in water, being 4,708 feet per second, still faster in steel and glass. These waves are longitudinal vibratory disturbance, different in this respect from the transverse wave motion of light; hence, while we can hear around a corner, we can not see around one unless mirrors are used to bend the rays. Also, we must understand that sound is generally an atmospheric vibration, while light is a vibration of the ether of space. Light, therefore, traverses space, but sound can not. Music is regularly recurring series of vibrations; a noise is due to an irregular or confused impulse. To be heard as a tone, the vibrations must number at least sixteen per second.

FACTS ABOUT COLOR.

Solar light is a compound substance, consisting of what is termed the seven prismatic colors, namely: red, orange, yellow, green, blue, indigo and violet. These when properly separated comprise the colors of the rainbow, and when combined in a beam, are called white light.

A BEAM OF SUN WAVES.

A beam of waves from the sun is composed of a bundle of ethereal waves, and these waves are of different lengths. The length of a light-wave is the distance from its crest to a similar point on the next wave. The different lengths of waves produce the different colors to our vision. Those productive of red require 39,000, placed end to end, to make the length of an inch, and those productive of violet require about 57,500.

THE COLOR, RED.

When we contemplate the beauty of the color we call red, as we see it in the rainbow, the solar spectrum, in the red leaves of a blooming rose or elsewhere in nature or in art, let us remember that to produce this color, 477,000,000,000,000 of little ethereal waves enter the eye and impinge on the retina in every second of time; and in the same interval 700,000,000,000,000 of these waves enter our eyes, and produce in us the sensation we call violet. When 577,000,000,000,000 impinge on the retina they produce the sensation of green, and the other colors between the red and the violet are all produced in the same manner.

COMPOUNDS OF COLORS.

A compound of red and green will produce white light. Yellow and blue will do the same, and for the same reason, because they are complementary colors.

NO SUBSTANCE HAS NATURAL COLOR.

No substance which we see in nature or art has any natural color. What we popularly term the color of an object is produced, and its color determined, solely by its power of absorption and reflection, and by these qualities alone.

LEAVES OF A TREE OR BLADES OF GRASS.

For this we will instance the leaves on a tree, the green grass, the beautiful flowers. A full sunbeam, with all its elements of color, is showered promiscuously on everything in nature, and the molecular construction of this green leaf, for instance, or of the grass, is such that it absorbs all of the ethereal waves except those of a given length, and these it repels or reflects; the reflected waves, twining back and impinging on the retina of the eye, produce in us the sensation of color, and that color is green. All the other waves are absorbed by the leaf, and produce heat instead of light.

THE PANSY.

The beautiful pansy absorbs all the rays of the solar beam except the shortest ones, that are capable of making themselves sensible to our visual organs, and these short waves are turned back by reflection, and, impinging on the retina of the eye, produce in us the sensation of violet; and so it is through all the range of colors. To repeat, every object in the natural world or the world of art receives the full beam of ethereal waves, or its full beam of colors, which are all the colors of the spectrum or rainbow. It then selects such of these waves, as owing to their length and the position of their planes of vibration, it is unable to absorb, reflects them back to the eye, and the length of these reflected waves determines the color of the object.

The coloring matter that makes the pigment which to us is black, absorbs *all* of the solar beams that fall upon it, and hence no color is reflected back to the eye; on the other hand the white paper on which we write absorbs none of these waves, but reflecting the entire beam back to the eye, we have a compound of all of the colors, and this compound is white; hence we call the paper white. As before said, color is not inherent in anything.

THE CYCLONE

The general ideas on the subject of cyclones are rather vague. Take a small butter pot, and set it down on your largest map of the world at about 20 degrees north latitude, anywhere in the Atlantic between two continents, say east of the West Indies.

ITS PATHWAY.

Then, with a piece of whalebone twice as long as from the butter pot to the North Pole, bent into a parabola, with one end at the pole, the other at the butter pot, mark out thus the path of the cyclone. The apex of the bent whalebone will be somewhere in the western United States. Imagine your butter pot to be revolving on its own center in the manner of the hands of a watch, at the rate 100 miles an hour.

ITS EDGES.

Its northwestern edge will be the dangerous storm rim, blowing a hurricane, lashing the seas, and precipitating the rain; the other edges will be breezy, but not so stormy, as they contain less moist air.

ITS CENTER.

The center will be the low barometer and calm area, because here the air has less weight and is flowing upward. Now, move your pot slowly along the parabola, still supposing it to be turning. By the time you reach the center of the United States, exchange the pot for a saucer, with the same supposed conditions, only by this time, if wintry, a snow storm will take the place of the rain. Keep it moving circularly, and northward also along the parabola, and about Hudson Bay, change to a breakfast plate, and in Greenland, to a dinner plate, and about the 80th degree north, before the storm reaches the size of a buggy wheel, it breaks up.

ENLARGEMENT OF THE STORM SPACE.

Thus you see the space over which the storm travels enlarges as it passes north, the winds blow around its rim, and the calm center moves with it.

THE HORN CARD.

Mariners now carry what is called a horn-card, a transparent piece of flat cow's horn, with a circle on it, inside which are several smaller circles, with arrows pointing as a watch's hands travel. Whenever the barometer changes and clouds scud by, this horn-card is placed on the chart at the ship's position. Knowing the wind's direction and the weight of the air, the horn-card tells whereabouts in the cyclone's course the ship is, and from this is reasoned how to sail to avoid its violence, or if unavoidable, how to manage in it, and if possible to profit by it.

HOW THE CYCLONE FORMS, DEVELOPS AND ADVANCES.

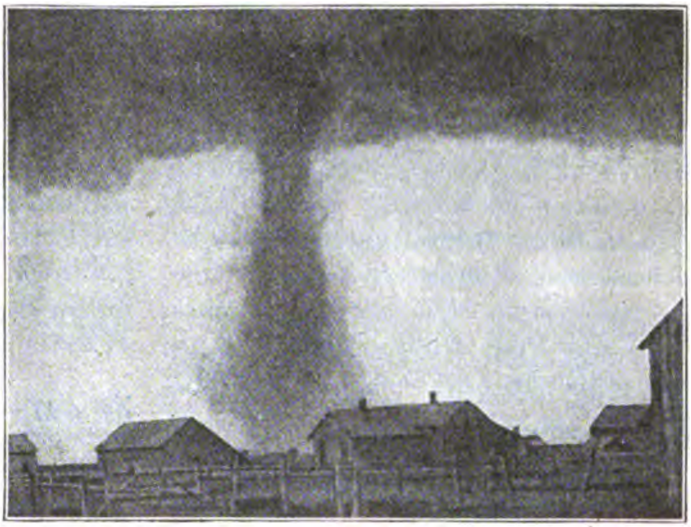
The formation and development of a cyclone is thus described by the intelligent observer of its progress, who furnished the accompanying illustration.

"In the afternoon a cloud of smoke was noticed on the horizon a few miles away. Spiral puffs arose from time to time, and we wondered whose house was burning. Presently we noticed a cloud in the sky above the burning house, of the same color, only darker.

"The cloud was quite a distance above, and entirely detached from the smoke below. While we looked a long finger suddenly descended from the upper cloud and touched the 'burning house,' and the two united and moved rapidly forward. Then we knew there was no burning house, and that we had witnessed the formation of a cyclone. Those who were nearer than we were told us that they first noticed a little whirl of dust, such as one often sees in a dusty road. Only a foot or two high at first, it usually scatters and disappears in a few minutes. This one did not. It rapidly grew larger and clung to the same spot. The cloud we saw in the sky did not come from anywhere. It suddenly formed in the sky above the little whirl of dust, grown larger by that time.

TWO CLOUDS UNITE.

"The two clouds moved forward at once on uniting. The long finger thickened at the top, forming an inverted cone. The lower cloud became absorbed in the upper, forming an immense, funnel-shaped, whirling horror, of inky blackness. Flashes of lightning constantly darted forth from its sides, and a sullen, thunderous roar was continuous. It moved with a swaying, graceful motion, rising and falling with the inequalities of the ground. It seemed to move slowly. A good horse could outrun it. As the long finger swayed back and forth whatever it touched vanished.


By courtesy of "The Oaks."

A CYCLONE AS IT STRIKES.
(From a photograph.)

"Houses, barns, haystacks and trees, all were taken up by the suction of the cyclone. The whirling motion was so rapid the eye could not follow it, but the forward movement was so slow that anyone who saw it in time could easily get out of its way. For that reason few lives were lost. It lasted three-quarters of an hour, then it struck a slight shower cloud and dispersed. Its track was eighteen miles long and one-quarter mile wide. It came within a half mile of our home. The courageous photographer who took the picture was handicapped somewhat by his shrieking family clinging to him and trying to get him into the cyclone cave.

"The photograph does not do justice to the 'sitter,' as at the moment of taking the shot it was passing over a plowed field, and the dust it kicked up destroyed the symmetry of its funnel. There was no other cloud in the sky except the cyclone. We could see the blue sky above and on all sides of it all the time, in unique and startling contrast."

UTILIZATION OF THE EARTH'S INTERIOR HEAT

Judging from present reports, the internal heat of the earth may soon be utilized as a source of industrial power. Along these lines the British Association for the Advancement of Science is making a series of measurements of underground temperatures, and Prof. William Halleck, of Columbia College, New York, says the plan is feasible.

INTENSE HEAT IN DEEP HOLES.

Recently, Prof. Halleck measured the temperature of some of the deep holes in the earth and found that there is a regular rise in temperature for every foot of depth, and in many regions intense heat is encountered at no great distance from the earth's surface. Learned men claim that the moment we obtain such power, the industrial map will be changed.

HOLES A MILE IN DEPTH.

Some holes are 1,000 feet and others one mile in depth. Others are deep wells, which have been sunk in search of gas, oil, water, and even salt, which is found a mile below the surface in Silesia. In Cornwall a zinc mine, 3,000 feet deep, extends out under the bed of the ocean nearly a mile from shore. In fact, men are crawling toward the center of the earth at the rate of several hundred feet a year.

AN ARTIFICIAL HOLE 7,000 FEET DEEP.

The greatest progress thus far has been made at Paruschowitz, in Silesia, where the deepest artificial hole is already 7,000 feet deep, or 400 feet more than a mile and a quarter.

AVERAGE TEMPERATURE 1,000 FEET DOWN, 128 DEGREES.

In this country a comparison has been made of the temperature in the various wells or holes at Pittsburg, Wheeling, Calumet and Houghton, and the average temperature at a depth of one thousand feet was found to be 128 degrees. In France the temperature in the coal mines at a depth of 3,600 feet is 117 degrees.

THE YERKES OBSERVATORY, WILLIAMS BAY, WISCONSIN.

SAVING THE FORESTS

A problem of vital importance presents itself to the American people in the preservation of its forests. For centuries, with the onward march of civilization, has been heard the sound of the ax, hewing away indiscriminately at the mighty trees of the country. While the damage from this onslought has not been irremediable, nevertheless, some sections of formerly beautiful and valuable country present a sorry sight. The lesson has been learned in many places that the forest lands must be protected.

Several advantages of forest saving are apparent at once. If lumbermen chop away at our noble trees without plan or scientific knowledge, but a few years will pass until serious results will follow. In the first place a constant supply of lumber cannot be insured unless means are taken to prevent felling of small trees, which are the beginnings of new forests. Without this young growth, future generations will be without lumber.

DISTRIBUTION OF MOISTURE DEPENDENT ON FORESTS.

Inhabitants of sections which were formerly well-wooded and now stand stripped of their timber, have discovered to their sorrow that the irrigation of the soil, even in a fertile country, depends greatly upon the forests. However much the forests may affect the rainfall itself, they have a powerful influence in the distribution of its moisture. The regulation of the flow of streams is mainly insured by forests. The heavy masses of tangled roots and matted leaves of the forest lands collect the moisture, and hold it pent up for a long time.

FORESTS PREVENT FLOODS AND DROUTH.

This prevents great floods during spring thaws, and, conversely, prevents seasons of drouth by allowing this stored up water gradually to find its way to the brooks and rivers. Thus, streams valuable for water power are preserved in their natural volume, and economic purposes are subserved. Compare the wildly-rushing, muddy stream, rolling in the spring through timber-stripped country, and the same stream dry, in the season when moisture is most needed in its valley for crop maturing, with that stream whose current is still regulated by kindly forests. This comparison has gradually become so effective that much good is resulting from it.

LESSEN THE NECESSITY FOR IRRIGATION.

As the tide of improvements moves further westward, the problem of developing arid and waste lands is being studied more closely. In the great deserts, scientific irrigation is already turning desolation into a paradise. Agriculture in the West depends more and more upon the forests. In many sections moisture depends upon storage reservoirs. These often give way through the breaking of dams. This can be obviated, but many others are stopped up with silt. This latter evil has only one remedy, the forest. Even the irrigation ditches receive their water from streams whose sources are in great forest reserves. When it is considered that there are in this country nearly one hundred million acres of land, not yet under cultivation, which may be reclaimed by irrigation, and that this land will support twenty million souls, the possible benefit from the preservation of forests may be imagined.

NATIONAL FOREST RESERVES.

The United States Government has taken a hand in this great work, congress having passed an act March 3, 1891, establishing national forest reserves. From President Harrison down, each successive executive has designated many acres of forest land to be set aside. In some instances in the West these reserves constitute the greater part of the whole territory of the State. In the whole United States there still remain nearly 1,000,000 square miles of timber land. Under the careful direction of the General Land Office, the United States Geological Survey and the Division of Forestry of the United States Department of Agriculture, much may be done with this timber.

There has been something of a hue and cry, due largely to selfish interests, against the establishing of the reservations. On some of the great public lands, sheep-grazing is an important and valuable industry. These sheep often stray through the forests in huge droves, trampling down the young tree growth and hardening the soil. Ruin to the woodland often follows, and that in itself would prevent further grazing. But the sheep herders overlooked this feature and fought against the reserves, fearing the exclusion of their sheep. When the true value of preserving the timber land was understood, and it became known that sheep could be grazed in small herds, the movement progressed rapidly.

DESTRUCTION OF FORESTS BY FIRE.

Fire alone, it is estimated, causes a loss of $50,000,000 a year to forests. In thickly timbered country this is little thought of, for what is plentiful is regarded cheaply. But the tremendous economical importance of this great national resource is being brought home to the many. In such States as are made up of treeless plains, timber must be had for building, else the onward march of civilization will cease.

THE RAINFALL AND DISTIBUTION OF FORESTS.

The distribution of forests in general corresponds with that of rainfalls. The Pacific coast has perhaps the finest and heaviest timber in the world. It is not the oldest States that have the smallest forests. Those that border on the Atlantic coast, with the exception of one, have a wooded area of more than 36 per cent of their entire territory. Louisiana has 62 per cent; Alabama, 74 per cent, and Texas, 24 per cent; about two-thirds of the surface of the Gulf States (except Texas) is covered with timber.

Iowa has only about 13 per cent, while North and South fall to 1 and 3 per cent, respectively. Nebraska has 3 per cent, and Kansas 7 per cent. These smaller yields are on the treeless plains. Toward the Rocky Mountains the timber grows heavier, and no States west of them have less than 10 per cent of woodland.

THE WORLD'S WATER POWER

Of recent years there has been great progress in the development of power from waterfalls. If the wasted waterfalls of the world were put to use driving electrical dynamos, sufficient power would be generated to supply the mechanical needs of the whole world. This fact has been recognized and a movement is now on foot in every direction to harness the wasted power.

NIAGARA FALLS.

Probably the greatest example of waterfall power is that at Niagara Falls. The chaining of the power of this great cataract is one of the most marvelous feats of mechanical engineering ever accomplished. A little more than ten years ago ground was broken for a tunnel which was to convey the waste water of the falls. To-day this same waste power generates more electricity than is produced under any other single roof in the world.

A GREAT POWER-HOUSE.

This great power house is over 450 feet long, the main portion of it covering a wheel pit 179 feet deep and 19 feet wide. Near the bottom of this pit are 10 turbines, each of 5,000 horse power, and each connected by a steel tube 166 feet long to a generator in the power house above. Each generator is capable of developing 5,000 horse power; thus the plant has 50,000 horse power. The water which furnishes this power is carried by means of a canal that taps the Niagara River one mile above the falls. The normal depth of the water in this canal is 12 feet. From it the water is led by penstocks directly to the wheel pit, and as it rushes upward it turns the turbines. After having performed its work, the water passes through a tunnel or tailrace built 200 feet below Niagara Falls and empties into the lower river. This tunnel is lined with brick from end to end.

A GREATER POWER-HOUSE.

Another power house with a capacity of developing 55,000 horse power is also fed by this tunnel. A second wheel pit with eleven turbines has been constructed, thus generating 105,000 horse power at this station from the formerly wasted water power of Niagara Falls.

VARIOUS USES FOR THE POWER THUS DEVELOPED.

The electricity thus developed is put to many uses. Formerly it was intended only to serve the city of Buffalo with power. This, however, proved a very small portion of the work that developed upon the plant. The Pan-American Exposition at Buffalo was furnished with electricity for its marvelous electrical exhibits. Thus, no matter how beautiful or potent the effect of the presence of the electrical power at the exposition, trace it as one might, the source of the energy was found miles and miles away down at Niagara Falls, where, day and night, through all the seasons, the mighty turbines and mammoth generators were swirling at the rate of 250 revolutions per minute. To impress more fully the magic power of the falls it may be said it could not be duplicated if 600,000 men performed the hardest kind of physical labor. Yet the great current there flows on forever.

SOME OF THE GREAT MILLS THAT USE NIAGARA'S POWER.

A NEW CITY.

Moreover, the supplying of light to Buffalo and nearby towns and to the Exposition was merely a phase of the early work of this great power plant. Around the falls has grown up a veritable city, with industries which derive their power from this current. Many of these industries depend upon processes in which chemical action is the chief factor. It would be nothing uncommon to run a cotton mill by this power, for it would be simply a substitute for steam. But this tremendous power of electricity enables the development of a heat of marvelous intensity, and by the means of electrical furnaces in the neighborhood, a new substance called carborundum is manufactured. This substance is as hard as a diamond, and is used for abrasive purposes, displacing emery wheels, etc. Great quantities of this cheap electric current are also used to reduce copper by the process of electrolysis, and a similar principle follows in the production of bleaching powders, aluminum, and many other things which are making Niagara Falls famous.

SENDING WATER POWER OVER LONG DISTANCES.

Great power is also being developed from waste water at other places. Some of the most remarkable examples of sending power over long distances are found in the Western States. Late improvements have resulted in transmitting a current 150 miles across the Rocky Mountains. Many cases are on record where pipe lines and flumes wind in and out through the mountains for many miles, gathering up waste water which finally plunges over turbines to develop electricity. By this method fuel, which formerly had to be packed zig-zag across the mountains on the backs of burros, at a heavy expense, is dispensed with.

Work in the mountain mines thus can go on night and day in winter as well as summer.

POWER GENERATED BY CANON WATER.

Near Salt Lake City power is generated by canon water, which passes from one power house to another, and after operating goes on down to a third house.

POWER FROM THE AMERICAN RIVER.

Sacramento has power for its light and its trolley cars generated by the American River 20 miles away. Many other cities in the West get heavy currents at long distances, creeks being harnessed for this purpose. Rapids in many streams bring forth great power. Foreign companies have taken up the method, and send thousands of horse power many miles.

ELECTRICITY FOR SAN FRANCISCO GENERATED 152 MILES AWAY.

San Francisco is served with electricity generated in the Blue Lake region in California, 152 miles away. The waters of the Yuba River supply a current to Oakland, California, 145 miles away.

VICTORIA FALLS.

Victoria Falls, in Central Africa, will sometime be harnessed and experts say that enough power could be transmitted to run all the machinery in the gold mines for the next twenty years.

RECLAIMING OF ARID AMERICA

In the far southwestern portion of the United States, in the section drained by the Colorado river, the Nile of the western continent, is progressing the great work of reclaiming the great southwest.

ALKALI PLAINS OF COLORADO.

Any one who has gone over this country knows too well the stifling heat of these alkali plains. Probably no more desolate place exists than the Colorado Desert on the borders of California and Mexico. And yet such is man's persistence and ingenuity that these arid stretches of waste will soon bloom like oases.

Irrigation has come to the rescue. The land in itself was fertile enough, and, in fact, the potentialities of the soil for everything known in agriculture are to-day wonderful. Further, the climate is such that with water, production will be bountiful. And work is going fast apace. Ere long lands that were strewn with the bleaching bones of unfortunate pioneers who were lost in this trackless country, will manifest their richness. Here are mountains of iron, coal and salt,—mines unworked whose ore would be worth a hundred dollars a ton at the smelter. Soon this is to be productive under the hand of advancing commercialism.

ARTIFICIAL CANAL AND OLD RIVER BEDS.

The railways have set the pace. With the knowledge that Los Angeles, which, although in blossom itself, is but a short distance from the desert, would profit ere long from the development of this country, railway magnates began pushing southwestward from Salt Lake City. Already the faith in the country has begun to reap rewards. But a short time ago, this natural bride of the Colorado river, this truly rich though seemingly valueless waste, was given the advantages of meager irrigation. The method was simple. Water was taken from the river near the Mexican border by means of a large artificial canal, and conducted through old river beds to the land to be watered. The old river beds needed very little done to them save cleaning of old brush in order to make them the channels of the system. For some 50 miles these river beds are used, and from them extends a system of lateral branches.

The land formerly was almost bare of vegetation, save that here and there were heavy growths of mesquite. But everywhere this delta of sedimentary deposit had a soil deep and rich. Now, instead of the somber scenes of useless desolation are springing up vistas of green fields, bubbling creeks and pleasant homes. Wherever the water touches the soil the growth is phenomenal. The climate is similar to that of Southern California and the greater part of the year is delightful. Vegetation springs to maturity almost in a single bound. Green corn is ready to eat in a double fortnight after planting. The date palm matures in five years. However, it is grain, alfalfa and live stock that will flourish most abundantly in this new paradise. Even Mexico will profit by the irrigation. Mexican lands have been purchased, water is taken to them by construction companies, and the canal system grows apace.

BOTTOMLESS LAKE—ROSWELL, NEW MEXICO.

How Artesian wells near Roswell may be made a great power for good.

TAPPING THE COLORADO RIVER.

The water supply itself when rightly led is everlasting. The Colorado river at its lowest stages carries enough water to irrigate 8,000,000 acres, and of these there are about 3,000,000 acres that can be thus improved simply by the force of gravity. One great engineering feat in connection with this wonderful land reclamation was that of tapping the Colorado. It was necessary to tap this stream so that there would be no danger of flooding the surrounding territory during high water season. This was done by selecting a spot where there was a natural heading in a hill of rock opposite the most powerful current in the river. Strong works of timber and stone were built here taking in the water at a depth of 9 feet below low level. This heading has already withstood heavy pressure successfully.

CONGRESS PROMOTES IRRIGATION.

After nine months of careful investigation the Geographical Survey Department of the United States decided upon five irrigation projects which are being developed under the terms of the arid-land reservation act of June, 1902.

One of these projects is the Gunnison tunnel scheme which is expected to reclaim nearly 100,000 acres near Montrose, in Central Colorado. In Nevada it is also proposed to divert water from Lake Tahoe, California, and its outlet, the Truekee river, into the Humboldt Valley, and supply settlers in the vicinity of Reno. Two hundred thousand acres may be reclaimed here. Then there are 500,000 acres along Milk River, in Montana, and 200,000 acres at Tonto Creek, which will be reclaimed.

In New Mexico artesian wells are being bored for use as means of irrigation, and great tracts of barren wilderness are being redeemed to the service of agriculture.

THE STUDY OF OTHER WORLDS

PIAZZI SEARCHING THE HEAVENS.

Although astronomy is at once the most beautiful and the most exact of the sciences, yet so little is really known of the limitless realms of the air, and so great are the possibilities for discovery, that scientists are constantly at work searching the heavens to solve their great mysteries.

IMMEASURABLE SPACE.

Most startling of the things to consider in the study of the starry sky is its immeasurable space. The earth, we know, is only one seemingly infinitesimal speck in the harmony of the universe. Millions upon millions of stars are traveling throughout space in some direction. Our solar system with its sun for a center, and its planets, stars and satellites, is not the only one thus in motion.

These systems, like the sun's, seem shooting off wildly into space, but who knows whether, centuries upon centuries from now, these seemingly wild flights may not shape themselves into orbits, similar to that of the earth.

But some of the stars are moving at such a terrific speed, in some cases hundreds of miles per second, that the attractive power of our universe can not influence their orbit. They must in time pass beyond the confines of our stellar universe. Such stars are called runaway stars. Several instances are known.

A CLEVER ILLUSTRATION.

We are amazed at the immensity of space. One well known astronomer has used a very clever illustration to indicate the size of the universe. He describes all known space as about the size of the United States. Upon this he lays an ordinary lady's finger ring, as the comparative extent of the earth's orbit. An actual mile away from the ring, he states as the comparative distance of the first fixed star. The constellation of Lyra is about ten miles from the ring, flying along at the rate of three hundred million miles a year, and all the space from the Atlantic ocean to the Mississippi river is filled with constellations, stars and planets. What wonder that even the mind of the scientist is awe-stricken.

PROBLEMS NOT YET SOLVED.

While we are wondering at the immensity of the universe, we are carried along into other problems which as yet the scientists have not solved. We know that friction causes heat. We see this in the combustion of the shooting stars, which we know do not start out on their journeys already on fire, but are heated and burned up because of the friction of the atmosphere, as they pass through its upper strata. Thus a few of the countless meteorites of space are rendered visible. They are said to be captured by our earth and their aggregate weight is sufficient to add some thousands of tons to the weight of the earth annually. We know that such glowing bodies as the stars are hot because of the contraction of their parts by gravitation. Perhaps all bodies are contracting and throwing off some heat. Where then does all the heat go? What becomes of the light also that has flown from the myriads of stars since the creation? We know that light flies at the rate of 186,000 miles a second. Can it be possible that in the millions of years since the earth began its formation, the light that first went off from the first sun has not reached the confines of space?

PLANETS VISIBLE TO THE NAKED EYE.

If these questions perplex us, what are we to say of the stars and planets which we can see with the naked eye? Is Mars inhabited? Does Venus have an atmosphere like that of our earth? What of the moon, so close to us that we think we can distinguish craters of worn-out volcanoes, and the dry beds of old rivers and oceans? What of the spots on the sun,—what causes them,—what is the corona about this body, and why does the sun seem so calm when it is a raging furnace?

THE COPERNICAN SYSTEM.

But while we leave astronomers to delve into the mysteries that remain, let us look into some of the things that we have learned concerning this science. The system of astronomy as now accepted is called the Copernican system, after Nicholas Kopernik, or Copernicus, who, in 1543, breaking away from the ideas of the scientists that preceded him, revived those of Pythagoras. He saw the beautiful simplicity of considering the sun the grand center about which revolve the earth and all the planets. He noticed how constantly, when we are riding swiftly, we forget our motion, and think that objects really stationary are gliding by us in the contrary direction. He applied this thought to the movements of the heavenly bodies, and maintained that, instead of the stars revolving around the earth every 24 hours, the earth simply turns on its axis; that this produces the apparent daily revolution of the sun and stars, while the yearly motion of the earth about the sun, transferred in the same manner to that body, would account for its various movements.

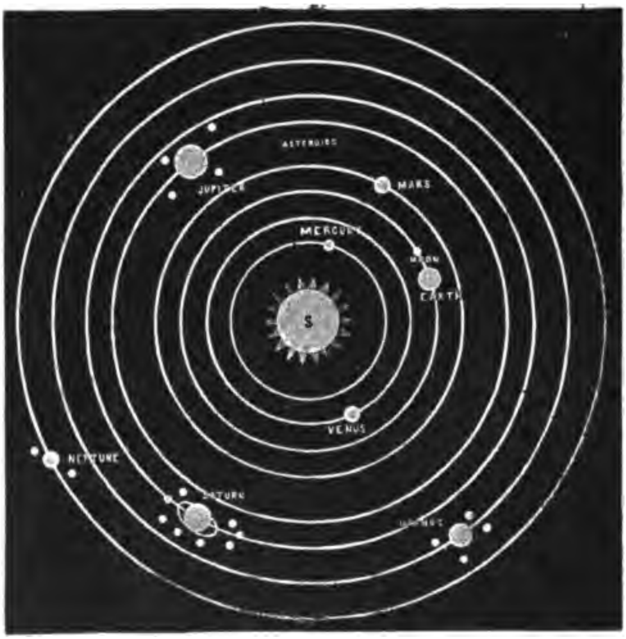
KEPLER AND THE TIDES.

Then came Kepler, who adopted the Copernican theory, and whose observations upon the planet Mars cleared away many complications. He also remarked that gravity was a power existing between all bodies, and reasoned upon the tides being caused by the attraction of the moon for the waters. About this time, namely, the beginning of the seventeenth century, the telescope was invented and logarithms came into use.

GALILEO AND THE TELESCOPE.

Galileo, who had discovered the laws of the pendulum and of falling bodies, learned that a Dutch watchmaker had invented a contrivance for making distant objects appear near. With his profound knowledge of optics and philosophical instruments, he instantly caught the idea, and soon had a telescope made that would enlarge things 30 times.

With this telescope he looked at the moon, discovered its valleys and mountains, and watched the heavy shadows sweep over its plains. Near Jupiter he saw three bright stars, as he considered them, which were invisible to the naked eye. Shortly after, he noticed those stars had changed their relative positions. Somewhat perplexed, he waited three days for a fair night in which to resume his observations. When he looked again the stars had shifted. After much observation he discovered a fourth star, and finally found that they were all rapidly revolving around Jupiter, each in its elliptical orbit, with its own rate of motion, and all accompanying the planet in its journey around the sun.



THE SOLAR SYSTEM.
Plan showing the Movements of Planets around the Sun.

Here was a miniature Copernican system hung up in the sky for all to observe for themselves.

Galileo met with the most bitter opposition. A great many refused to look through the telescope, lest they might become the victims of the philosopher's magic. Some prated of the wickedness of digging out valleys in the fair face of the moon, while others doggedly clung to the theory they had held from their youth up.

NEWTON AND GRAVITATION.

Then Newton promulgated his immortal discovery of the law of gravitation. Subsequent researches brought astronomy into prominence more and more. The spectroscope has revealed elements existing in the vapors and compositions of the sun and of the heavenly bodies. Stars are now known to be suns, some bearing a great resemblance to our sun, and others differing materially.

ASTRONOMICAL INSTRUMENTS.

Instruments for astronomical observation have now been brought to a pitch of perfection scarcely ever dreamed of, and month by month discoveries are made and recorded, while calculations as to certain combinations can be made with almost miraculous accuracy. The transit of Venus, the approaches of comets, eclipses, and the movements of stars are now known precisely, and commented on long before the events can take place.

GREATEST TELESCOPE IN THE WORLD.

And here let us describe one of the greatest telescope in the world. This instrument is known as the Yerkes telescope, and is located in the observatory of the astronomical department of the University of Chicago, on the shores of Lake Geneva, Wisconsin. At the time this observatory was erected, the 40-inch lens of its telescope was the largest ever built; but such is the rapid advance of science that several larger are now in use, and one of 100 inches is building. The large glasses of the lenses were ground by Alvin Clark. The glass, proper, is made up of two lenses one of flint glass and the other of crown glass, ranging in thickness from ¾ of an inch to 2 inches, and poised 8 inches apart. Clark was engaged four years in polishing them and the last touches were done by his finger tips. The glasses weigh 500 pounds. Contrary to general opinion, small scratches and dust do not prevent clear vision through this glass and no protection is placer over it.

THE LICK OBSERVATORY.
As Seen at a Distance.

ITS MAMMOTH TUBE.

The great tube of the telescope weighs 20 tons and is 65 feet long, yet so delicate is the mechanism, so perfect are the motors, and so carefully poised is the instrument, that it can be adjusted instantly. This monster eye is housed under a 90-foot dome, beneath which is a large floor, weighing 40 tons, which by means of electrical motors, can be lifted to a height even with the eyepiece of the telescope. The dome is also movable on a circular track, so that at the will of the operator the telescope may be trained through a great opening in the dome, upon any quarter of the heavens. Within the base of the telescope is a clockwork arrangement which keeps the tube moving steadily in the path of the star under study, as well as adjusting its workings. This telescope cost, together with the observatory, a half million dollars.

With the magnificent telescopes of the present, the other wonderful astronomical instruments of recent invention, such as the spectroheliograph, the perfected spectroscope and improved stellar photography, great advance has been won in astronomy. But every step in advance discloses a bewildering complex of mysteries beyond.

NEW USE FOR SPIDER'S THREAD.

Silk threads, finely spun glass, the finest of platinum wire are all coarse beside the delicate threads spiders spin. Accordingly, such threads are used in delicate measurements over the field of the telescopic lens. The best trained observers might differ when a star was exactly on the center of the lens, a relatively coarse thread like the finest platinum wire is thick enough to vitiate the result. Spider thread is the best means whereby to determine the exact fraction of second when a star comes to the meridian of the telescope. By a series of such observations, continued throughout the year, astronomers compute the parallax of some of the fixed stars, and thus determine their distance. Another use of such delicate threads is to determine the exact location on the spectrum scale of the lines emitted by the light of a star and thus learn the elements of which it is composed.

THE SOLAR SYSTEM.

The solar system consists of the sun, the center; the major planets, Mercury, Venus, the Earth, Mars, Jupiter, Saturn, Uranus, Neptune, the asteroid, or minor planets, the satellites or moons which revolve around the several planets; meteors, and comets. The planets haye certain motions, going from East to West, from West to East, and sometimes again appearing quite motionless. This change of place from one side of the sun to another, has given them their title of "wanderers." The planets and their satellites, the asteroids, comets and meteors, all circle around the sun in more or less regular orbits. There are probably families of comets that have not yet appeared to us, and whole systems of meteors as yet unseen.

THE SUN.

The sun is an immense sphere of gas, but within the surface, the pressure must be so very great and the temperature so excessive that we can not even imagine the conditions there prevailing. There must be a constant uprising of superheated gas from within, and a corresponding down draught of relatively cooled gas from the surface, consequently the surface of the sun must be the seat of great cyclonic disturbances and violent upheavals, the intensity of which we can only imagine. The atmosphere of the sun is composed of glowing gas and extends out for thousands of miles. Spectrum analysis shows us that 36 of the elements in that glowing gas, such as iron, calcium, carbon, etc., are the same as on our earth.

ITS SIZE AND DISTANCE FROM THE EARTH.

The sun's average distance from the earth is 91,500,000 miles. The volume of the sun is 1,253,000 times that of the earth, but its density is only about one-fourth that of the earth. The attraction of gravitation at the sun must be 27 times more than that of the earth's surface. A body dropped near the surface of the sun would fall 436 feet in the first second, and would then attain a velocity of ten miles a minute.

ITS LIGHT.

The light of the sun is equal to 5,563 wax candles held at a distance of one foot from the eye. It would require 800,000 full moons to produce a day as brilliant as one of cloudless sunshine. The amount of heat we receive annually is sufficient to melt a layer of ice 38 yards in thickness, extending over the whole earth. Sun spots, as they are generally called, are hollows in the sun's vapory substance, and are of enormous extent, and there are brilliant places near those spots, which are termed faculæ. These spots have been observed to be changing continuously, and passing from East to West across the sun, and then appearing again at the East, to go over the same space again. This fact has proved that the sun turns around upon its axis. Although it does not move, as we imagine, from East to West, around the earth, it does move. In fact, the sun has three motions: one on its axis, a motion about the center of gravity of the solar system, and a progressive movement toward the constellation Hercules.

NUMBER OF THE PLANETS.

The ancients knew five of the planets, and named them Mercury, Venus, Mars, Jupiter and Saturn. In later years a great number were discovered, but the principal ones are eight in number, including our own earth, Uranus and Neptune. All the planets are spheroids and vary greatly in size. Comparing their size and magnitude, Sir John Herschel said: "Choose any well-leveled field, and on it place a globe two feet in diameter to represent the sun. Mercury will be represented by a grain of mustard seed on the circumference, with an orbit 164 feet in diameter; Venus is represented by a pea, in a circle 284 feet in diameter; the earth also by a pea, in a circle of 430 feet; Mars, a rather large pin's head, in a circle of 654 feet; Juno, Ceres, Vesta and Pallas, grains of sand in orbits of 1,000 to 1,200 feet; Jupiter, a moderate sized orange, in a circle nearly half a mile across; Saturn, a small orange, in a circle four-fifths of a mile across, and Uranus, a full-sized cherry, or small plum, upon the circumference, more than a mile and a half in diameter."

MERCURY.

The distance of Mercury from the sun is less than half that of our earth, and so it receives much more heat and light than do we. The sun viewed from that planet, if such a thing were possible, would appear seven times larger than from the earth. Mercury's orbit is the most eccentric of any of the eight principal planets, so that, although when in perihelion it approaches to within 28,000,000 miles, in aphelion, it speeds away 15,000,000 miles further, or to the distance of 43,000,000 miles. Being so near the sun, its motion in its orbit is correspondingly rapid—30 miles a second.

VENUS.

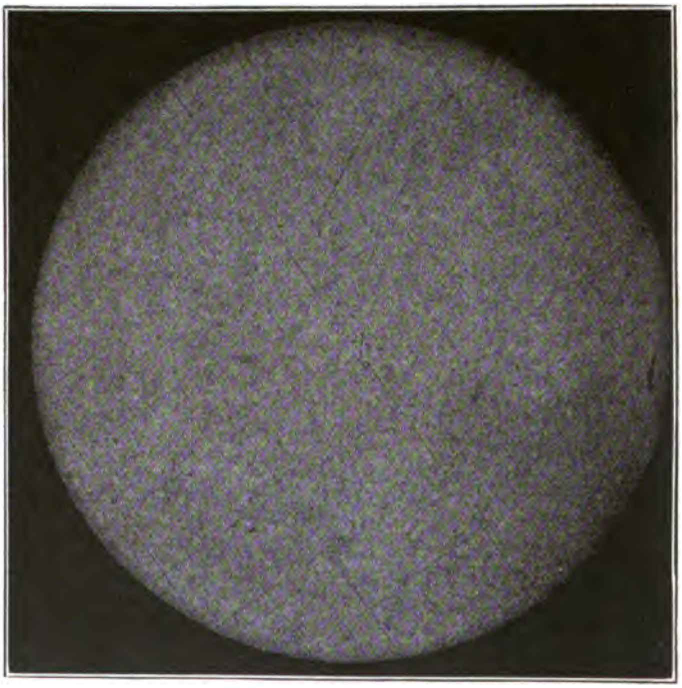
Venus, the nearest planet to the earth, is somewhat smaller than our globe. It is both a morning and an evening star, and shines with great brilliancy. It can scarcely be doubted that Venus is surrounded by an atmosphere denser than our own. The observations made during successive transits seem to have established the fact that aqueous vapor exists around Venus and that water exists in it.

THE EARTH.

It seems rather strange to class our earth, which is dark and opaque, and which appears to us so vast, among the bright heavenly bodies. Nevertheless, it is one of the smallest of the principal planets of the solar system, and although we see in it no motion, while the orbs about us seem constantly changing their positions, science has shown that the earth revolves around the sun in an orbit of nearly 600,000,000 miles, at the tremendous rate of 18 miles a second, or 65,000 miles an hour. To other worlds our earth appears as a star does to us. In studying astronomy we must consider that it is a planet shining brightly in the heavens, held in its course by the invisible power of gravitation, and that in reality it is small and insignificant beside some of the mighty spheres that so gently shine upon us from distances almost inconceivable. Our earth, in fact, is only one atom in a universe of worlds, the majority of which are suns and may be attended by retinues of planets fitted to support life.

THE MOON.

The moon is the satellite of the earth. "Fancy," says Lockyer, "a world without ice, cloud, rain or snow; without rivers or streams, and therefore, without vegetation to support animal life; a world without twilight, or any gradations between the fiercest sunshine and the blackest night; a world also without sound, for, as sound is carried by the air, the highest mountain on the airless moon might be riven by an earthquake inaudibly."



TRANSIT OF VENUS.

ITS DIAMETER, AND DISTANCE FROM THE EARTH.

The diameter of the moon is about 2,160 miles, and it is much less dense than our earth; therefore the force of gravity is less there than here. Its mean distance from us is 238,833 miles. It goes through certain changes or phases about every 29 days, and while rotating on its own axis, it goes around the earth, so that we can see only one side of the moon, inasmuch as the two motions occupy almost exactly the same length of time. Thus we generally see the same space of the moon, though at times there is a slight variation. The moon passes the sun periodically, and so if she moved in the plane of the ecliptic, there would be eclipses of the sun and moon twice a month. But as the orbit is inclined somewhat, the moon escapes by moving north or south.

ECLIPSES.

There are eclipses of the sun and of the moon. The former occur at the time of the new moon and the latter at full moon. This can be understood readily when we remember that the sun is eclipsed by the moon passing between us and the sun. The moon is eclipsed because the shadow of the earth falls upon her when it is opposite the sun, and therefore "full."

NORTHERN LIGHTS.

EBB AND FLOW OF THE TIDES.

The ebb and flow of tidal water depend upon the moon to a great extent. Twice every day we have the tides, twelve hours apart, and the flow and ebb are merely examples of the attraction of gravitation, which is exercised on all bodies, whether liquid or solid.

MARS.

Mars appears to the naked eye as a bright red star, rarely scintillating and shining with a steady light which distinguishes it from the fixed stars. Its ruddy appearance has led to its being celebrated among all nations. The Jews called it "blazing," and it bore in other languages a similar name. The orbit of this planet is exterior to the earth's, as is proved by it never appearing "horned" nor ever passing across the sun's disk. Therefore, no transits of Mars can take place as do transits of Venus and Mercury. Mars is most

By courtesy of Allen L. Cotton.
THE MOON—FROM A PHOTOGRAPH TAKEN AT THE LICK OBSERVATORY.

like the earth of all the planets. There appears to be a white or snowy region near its poles at varying periods, which would lead us to the conclusion that the changes of atmosphere and the seasons are similar to our own; and as the inclination of the planet is nearly the same as that of the earth, this supposition may be accepted as a fact. Mars is attended by two satellites, or moons, discovered in 1877, both very small.

JUPITER.

Jupiter is called the giant planet, and is 1,300 times larger than the earth. Its mean diameter is 86,500 miles, with 270,000 miles' circumference. Its inclination is very small, and therefore the changes of seasons are very slight. It has four satellites. These moons act, with respect to Jupiter, very much as the latter acts with respect to the sun. Jupiter is the largest of the planets, and only Venus is brighter. It revolves at a distance of 476,000,000 miles from the sun and 390,000,000 miles from the earth, and its year is equal to nearly twelve of ours, while its day is scarcely ten hours long, showing a rapidity of motion more than 20 times that of the earth.

Jupiter is an example of a sun just ceasing; of a planet just commencing. There can be no such a thing as mountains, or a generally solid surface, and no phenomena like changing seasons. The partially incrusted surface of the planet must be constantly changing, and presents in general the appearance of our volcano, Kilauea. We catch only glimpses of the surface; what we gaze upon is an immense expanse of clouds.

SATURN.

Saturn is a great globe surrounded by a beautiful bright ring or series of rings, and attended by eight satellites. It appears to have much the same constitution as Jupiter, but is enveloped in an atmosphere even denser. It revolves on an inclined axis and has seasons unequal in length.

ITS RINGS.

The rings of this planet are apparently broad, flat and thin, resembling roughly the horizon of the globe, and are supposed to be a close agglomeration of stars or satellites, revolving around the planet and encircling it in a belt. The two outermost rings are very bright, the inner ring being darker and partially transparent, for the ball of Saturn can be perceived through it. Saturn, on account of its distance, shines with a feeble, pale, yellow light, which is steady and distinguishes it from the fixed stars.

ITS ORBIT.

Its orbit is so vast that its movements among the constellations may be traced readily through one's lifetime. It takes two years and a half to pass through a single sign of the zodiac; hence when once known, it may be found easily again. As the earth and Saturn occupy different portions of their orbit, the distances between them at different times may vary 200,000,000 miles.

URANUS.

Uranus was discovered by Herschel in 1781. It revolves at an enormous distance from the sun, namely, 1,753,000,000 miles. It takes about 84 of our years to go around the sun, and it possesses four moons. It is about four times larger than the earth in diameter, and about 40 times in volume. We can only speculate concerning its physical constitution, which is assumed to be similar to that of Jupiter, while the changes of temperature and seasons must vary immensely.

NEPTUNE.

Neptune is the far-off sentinel at the very outposts of the solar system. The existence of this planet was determined by calculation before it had been seen at all. Uranus was observed to be disturbed in its orbit, moving sometimes faster than at other times, and even before Uranus had been discovered, Saturn and Jupiter had been seen to be affected by some other body in the system. Very little can be said concerning this planet, as its distance is too great for good observation. It has one moon, which moves about the planet in five days and 21 hours, and is of great size.

THE ASTEROIDS.

The asteroids are smaller planets circulating outside the orbit of Mars. They are all at distances from the sun ranging between 200,000,000 and 300,000,000 miles, the periods of sidereal revolution ranging from 1,100 to 3,000 days. Consequently their years are from three to nine times as long as ours. Nearly 250 of these minor planets have been discovered. They are all very much smaller than the earth.

METEORS.

A meteorite is an extremely small planet; an aerolite is a meteor large enough to withstand the fiery plunge through our atmosphere; a great stream of meteorites, condensed in a rushing center, is a comet. The asteroid, of which there are doubtless many thousands, constitute a great ring of aerolites, moving in a well-defined orbit. A few of them are large enough to be seen from the earth. Space in and adjacent to the plane of the ecliptic is full of these infinitesimal planets, all obeying the laws of planetary motion, all traveling with the sun through space and all members of our solar system. Perhaps they are fragments of two suns whose collision formed our system.

COMETS.

It has been lately suggested that there is a great degree of affinity between comets and meteors, in fact, that a comet is merely an aggregation of meteors. Comets have been supposed to be bodies of burning gas. Their mass is very great and their brilliant tails are many millions of miles in extent. In their orbits they differ greatly from the planets. While the latter are direct in their wanderings, comets are more irregular and eccentric. When first seen, the comet resembles a faint spot of light upon the dark background of the sky. As it comes nearer, the brightness increases and the tail begins to show itself. The term comet signifies a hairy body. A comet consists usually of three parts, the nucleus, a bright point in the center of the head, the coma, a cloud-like mass surrounding the nucleus, and the tail, which is a luminous train extending generally in a direction from the sun. It is not understood whether comets shine by their own or by reflected light.

THE FIXED STARS.

The fixed stars are those which apparently remain immovable and shine with a shifting, twinkling light, although it is known now that they also are in motion. The number of the stars is beyond our calculation. Those visible only in the telescope amount to millions. The stars visible to the unaided eye are about 6,000, in number. There are more visible in the southern than in the northern hemisphere.

DISTANCE OF THE STARS

The distance of the stars is so very great that measuring it was very difficult of solution. But at length, with more perfect instruments, careful and long-continued observation, we have succeeded by direct measurements in determining the distance of a large number of stars; and by various methods the distances of still others have been estimated. There is a general agreement among astronomers, as to the substantial accuracy of these results. When the distance was learned, it was necessary to use some new measure to express it, since the figures carried absolutely no meaning. The unit chosen is the distance light travels in one year. We know the distance it travels in one second is about 186,000 miles. The result for one year is an inconceivable number, but it is the best unit we can find.

OUR NEAREST STAR.

The nearest star whose distance has been determined is in the constellation of the Centaur and so not visible in the northern hemisphere. Its distance is so great that it requires light three and a half years to cross the void. That is our nearest stellar neighbor. Now by similar methods of direct measurements we measure the distance of stars up to one hundred light years away. But this is only a beginning. By careful investigations of double stars, the details of which it is useless to give, of 157 examples studied it came out that only five were less than two hundred light years distant. At this point, we must do our best to greatly enlarge our concept of space, for about one-half the number examined were about 2,000 light years distant, and a considerable number were double this last distance.

THE STELLAR UNIVERSES.

Our sun is but one of many million stars which shine in the heavens. The arrangement of this mass of stars is not globular. It may be compared to an enormous but relatively thin lens shaped portion of space, greatly elongated. Our sun is supposed to be situated, relatively speaking, near the center of this lens. When we look at the Milky Way we are thought to be looking towards the edge of the lens, the vast number of stars in that direction, and so inconceivably distant that we can not see the stars separately but only the diffused glow of their light. From what we have just learned of the distance of some of these stars, we can form a vague conception of the dimensions of our universe. They are such that it would take light perhaps 1,000 years to pierce the thickness of the lens, several thousand years, however, to cross its diameter.

NEBULAE.

No one can contemplate the results just named without feelings of awe. But it seems we shall have to greatly enlarge even these concepts. Here and there in the sky, a telescope of moderate power discloses patches of diffused light. Such patches are called nebulæ. One of the greatest known is in the constellation Andromeda, another is in the sword handle of Orion. When the heavens are photographed by large telescopes, the numbers of nebulæ rapidly increase, running into the hundreds of thousands. It is useless, in the space at command, to attempt any description of nebulæ. We might say they fall into several classes. Some are immense expanses of cosmic gas, others represent stellar universes in various stages of evolution. Some are immense collections of stars like our own universe.

DISTANCES OF THE NEBULAE.

The distances of some of these nebulæ from us, their dimensions, and rapidity of motion, are absolutely appalling. The average distance of the spiral nebulæ is supposed to exceed 20,000 light years. The Magellanic Clouds are about 30,000 light years distant, and even these distances represent minimum figures. The dimensions are such, that as in our own system it must take light on an average several thousand years to cross their boundaries.

RATE OF MOVEMENT OF NEBULAE.

And these immense universes are in rapid motion as a whole. The same must be true of our own universe. The speed as a whole is far greater than anything we have heretofore known. The spectrum tells us of the rapidity of motion in the line of sight, directly towards us, or the reverse. The average velocity of fifteen nebulæ, so far observed in the line of sight, is 250 miles a second, that is, about twenty-five times the average rate of flight of about 1,000 stars, so far determined. Some of these nebulæ are approaching our system, others receding. The great nebula in Andromeda is approaching us at the rate of about 200 miles a second, but one in Virgo is receding at the tremendous rate of 350 miles per second. Even these figures do not express the total velocity of nebulæ in space, since the spectrum tells us nothing of the motion in any direction except the line of sight, and in very few instances can that be all the motion.

It is utterly beyond our ability to comprehend how such enormous velocities originated. It is another insoluble mystery.

COSMOGONY

Theories put forth to account for the present condition of our solar system, or of greater aggregates, as our stellar universe, the stages of growth through which they have passed, and what is to be the final results, are theories of cosmogony. In general, such theories have only included our solar system and, of course, other solar systems, like ours. The nebular hypothesis is a very celebrated one, put forth by the great astronomer, Laplace. It is not, however, accepted in its entirety by any astronomer of the present day, but no hypothesis has received universal adherence. Of course, the first of the series of astronomical changes is an impenetrable mystery. We are certain of only one thing. Our solar system had a beginning. It is now in its prime. It will in time expire in night; that is to say, the sun will cool down, its surface will in time crust over, the same as our earth has done in the past, the same as Jupiter is now doing. When that time comes, our system will be dead. That is, the planets, cold and dark, will revolve around the sun, also cold and dark. Universal death and night will rule. It is supposed there are even now more dead systems swinging in space than there are living ones. And it is thought collisions of such suns occur.

POSSIBLE RENEWAL OF THE CYCLE.

Will the cycle ever begin anew? Not with the sun and planets as they are now. There is, however, one possible means by which sun and planets both may be dissipated into fragments and form again a nebulous mass, or a mass like some of the nebulæ, for they are not all constituted on the same plan. That would be in case our system should collide in space with some other dead system. It is thought by some that we see just such fiery revivals as this in the sudden flashing out of new stars in distant space, relatively a frequent phenomena, and it is thought by some that our present solar system came into being in just that way, and that the aerolites which have landed on the surface of our earth, showing all evidence of being fragments of larger bodies, are portions of these ancient, colliding systems. The human mind stands aghast at the antiquity such a hypothesis demands for these wanderers in space. They represent not millions but billions of years.

THE GEOLOGICAL AGES

Geology has to do with the past history of our planet. Scholars who have tried to divide the time that must have elapsed since the "beginning" into divisons, which are distinguished among other differences by the different forms of life, both animal and plant, that characterized them. There are several schemes of classification, and each has some points of superiority.

ARCHEAN TIME.

This includes that long period of time during which there could have been no life, as we understand the term, on the globe. We have no means of determining how long this period was. Manifestly no life could have existed until the surface crust had formed, virtually, over the entire globe; the waters precipitated from the overburdened atmosphere; and thus the shells of clouds dissolved, and the new planet looked forth on the universe. Not until all this had taken place could life, as we know it, begin its career of gradual unfoldment. All this must have required the passage of a well-nigh infinite series of years. Towards the close of this extended period of time faint traces of life appear. But this was not life as we are apt to think of it. No nodding flowers were kissed by the sunshine of that early time. The earliest forms of flowerless plants such as sea weeds, and in dry places, lichens covering the rocks, were the highest forms of plant life. It is doubtful whether any forms of animal life were present, but if so, they were simply structureless bodies. Such was the immensely long period of time, doubtless many times longer than the time that has elapsed since its close, known as Archean Time.

PALEOZOIC TIME.

Paleozoic means old life, so Paleozoic Time means that portion of time characterized by the presence of those life forms, both animal and plant, that we recognize as crude, old in the sense of time, not well developed. This period witnessed the wonderful development of plants which produced the great beds of coal that we have today. There was a great profusion of flowerless plants, all over the temperate zone, great tree ferns, thirty feet or so in height, were growing, such species now, in the warmest portions of the earth only grow a few feet high. Some varieties of rushes that now grow a foot or so high had representatives in the marshes of the coal measures standing thirty feet high with woody trunks. Not until near the close of this period do we find evidence of the presence of flowering plants. But pines were growing in the coal measures.

A similar advance in animal life is noted. Invertebrate animals were largely represented; not until towards its close do we meet with backboned animals, such as fishes, amphibians and reptiles. We are to note that the earlier forms of animal life were all water forms; not until the closing portion do we find air-breathing animals. In the forests we would have seen none of the beautiful flowers we associate with tropical vegetation today. In the branches of the graceful tree ferns we would have looked in vain for birds; they were far in the future. None of the higher forms of life were present. There was not a single representative of the class Mammalia. There were fishes in the waters, but not the fishes of today. There were some amphibians and reptiles in the marshes, but they were unimportant. This period of time was also immensely long, probably far longer than all the time that has elapsed since its close, though it was but a fraction of the time represented in the first period.

MESOZOIC TIME.

Mesozoic means middle life and Mesozoic Time is that portion of time in which the prevailing life forms were intermediate in character between the old forms and those of the present. Great geographical changes ushered in this period and put an end to the conditions under which old life forms had been developed and in which they flourished. Changed conditions demanded new life forms. The abundant, flowerless vegetation of the coal measures of the preceding epoch dwindled away, flowering trees increased in number and importance, and in the closing portions of this period we have trees with deciduous leaves. A great many of our present forest trees had representatives in the forests of that time. Palms and trees akin to the big trees of California were growing side by side.

Of animal life there were many strange forms. It was the age of reptiles. They domineered on the land, in the air, and in the sea. On the land stalked huge reptiles, fifty and sixty feet long, which, when standing erect, must have been at least thirty feet high. Some of these huge creatures were carnivorous, living on other animals. Others fed on the foliage of trees. In the air, huge reptilian bats, veritable flying dragons, with a spread of wings from ten to twenty feet, disported themselves. In the sea there swam great reptilian whales, seals and walruses. Birds made their first appearance during this period, and here we obtain a clear view of nature methods; the first birds were simply modified reptiles. They had long, jointed tails and bills well supplied with formidable teeth. Finally, it is in the rocks of this era that remains of the class mammalia make their first appearance. This period of time was doubtless long continued.

TERTIARY TIME.

All the time that has elapsed since the close of the Mesozoic Time is known as the Cenozoic Time. This means the time of new life forms, and included animals and plants, like unto those at present living. Owing to its importance, it is subdivided first into the Tertiary Age. Tertiary means third; that is, it was the third period of life forms from the Archean time. The Tertiary Age is also known as the age of mammals. To the class mammals belong the most highly organized animals, and they have been the ruling type of animals since Mesozoic times. In the forests of the Tertiary Age all our present trees were growing, oaks, poplars, maples, hickories, etc. The climate was mild far to the north. Palms were growing in the upper Missouri region; England was decidedly the land of palms; no less than thirteen species were growing there, and there were at least eleven species growing in Switzerland, and one variety grew as far north as Northern Germany.

There was a great increase in all the higher forms of life. Whale-like animals were especially abundant in the sea. On our western plains were animals like the tapirs of India and rhinoceros-like animals as large as elephants, and diminutive little animals not larger than foxes, from which have come our horses. Quadrumana, or apes, were living in Europe. Mastodons and other huge animals of the elephant type were also common. Birds of all kinds were abundant. Finally, and more important than all, man made his appearance at least as early as the close of the period in question.

RECENT OR QUARTENARY TIMES.

All the time that has elapsed since the close of the Tertiary Age is known as the Quarternary (Fourth) or recent time. It includes the present. But here again the whole stretch of time included in this term is of immense duration and extends over many thousands of years. Before noticing its distinguishing characteristics, we should by way of review grasp the fact that all through the various ages there was a slow and orderly advance in life forms. From sea weeds to the giant sequoia; from structureless cells to man. Thus the Almighty Power "from out whose hands the centuries fall like grains of sand" ordered all things.

THE GLACIAL AGE.

The Quarternary Time is still further subdivided, and in the first division we find that remarkable period known as the Glacial Age. It is on the whole the most mysterious period in our planet's history. For some reason, probably the continued elevation of the land to the north, the mild and genial climate of Tertiary times, when palms were growing far north in the United States and Europe, when Greenland and Spitzbergen enjoyed temperate conditions, passed away and true Arctic conditions, like those prevailing in Greenland to-day replaced them.

Just as Greenland is smothered beneath a huge ice sheet, so Europe as far south as Italy and Spain was covered by a desolating layer of ice. In the United States, ice, most of the way at least a mile in thickness, covered all the country as far south as the Ohio River, as far west as Indiana, where it curved to northern Illinois, thence west to the great plains and the Rocky Mountains.

The fact is unquestioned; the explanation is obscure; the time in years since these conditions passed away is not definitely known; probably, comparatively, but a few thousand years ago, some would place it at ten thousand years or less, other geologists much farther away in time. Its gradual coming on from the close of the Tertiary Age can be traced in the vegetation of the period just preceding the Glacial. This period was probably very long. The continuance of glacial conditions was doubtless many thousand years. When it passed away, the present age in geological history began.

THE FUTURE.

We have no reason to suppose the cycle of changes is complete. There will be geographical and climatic changes in the future. There is, however, this difference. Man has appeared as the fitting climax of all that preceded him. No higher order of life will appear; improvement will show itself in improved men, that is, increase in knowledge, enlightenment and civilization. He has advanced in all these directions with great rapidity in recent centuries. Man is endowed with reasoning powers and can thus assist nature in her selective work.

This we are now doing. We are assisting nature in developing new species of vegetables, fruits, grains and grasses. We are developing those that can stand arid conditions, that can adjust themselves to colder latitudes than their natural home. The same is true of animal forms. By assisting nature in her selective work, we produce new varieties of domestic animals. Thus we are learning how to guide the evolutionary forces of nature. In various ways we are learning how to rise superior to climatic conditions. We are making more and greater use of irrigation to control arid conditions. Why can we not in some way control climatic conditions? This is at present a dream of enthusiasts. It may some day be a reality. It does not seem a more difficult thing to do than would have seemed the enlightenment of this steam and electrical age to the men of several thousand years ago.

What wonderful results have followed the discovery of a way in which to utilize the inter-molecular forces of nature stored in the immense coal deposits of an earlier age! Who can estimate the more marvelous advance that man can make should he learn how to utilize the boundless stores of interatomic energy concerning which the mysterious actions of radium give us a hint? Why may we not hope some day to discover a process that will enable us to do this? And so we have reasons to look forward to a more glorified age in the future—an age of enlightenment which shall be a fitting climax to all that has preceded it; which shall as much exceed the present as the present exceeds the civilization of the past, or as the light of brightest day exceeds the mellow glow of moonlit nights.

QUESTIONS ON POPULAR SCIENCE.

On what does all science depend?

How can we increase the area of fertile land?

How does Nature fixate nitrogen?

How can we avail ourselves of Nature's help?

What is meant by educating plants?

Mention some plants made to order.

Mention some results attained by Mr. Burbank.

What weed did Mr. Burbank change to a flower? How did he do it?

Give an account of the spineless cactus?

How far can plant improvement go?

What do you mean by the resisting power of plants.

Mention some germ diseases.

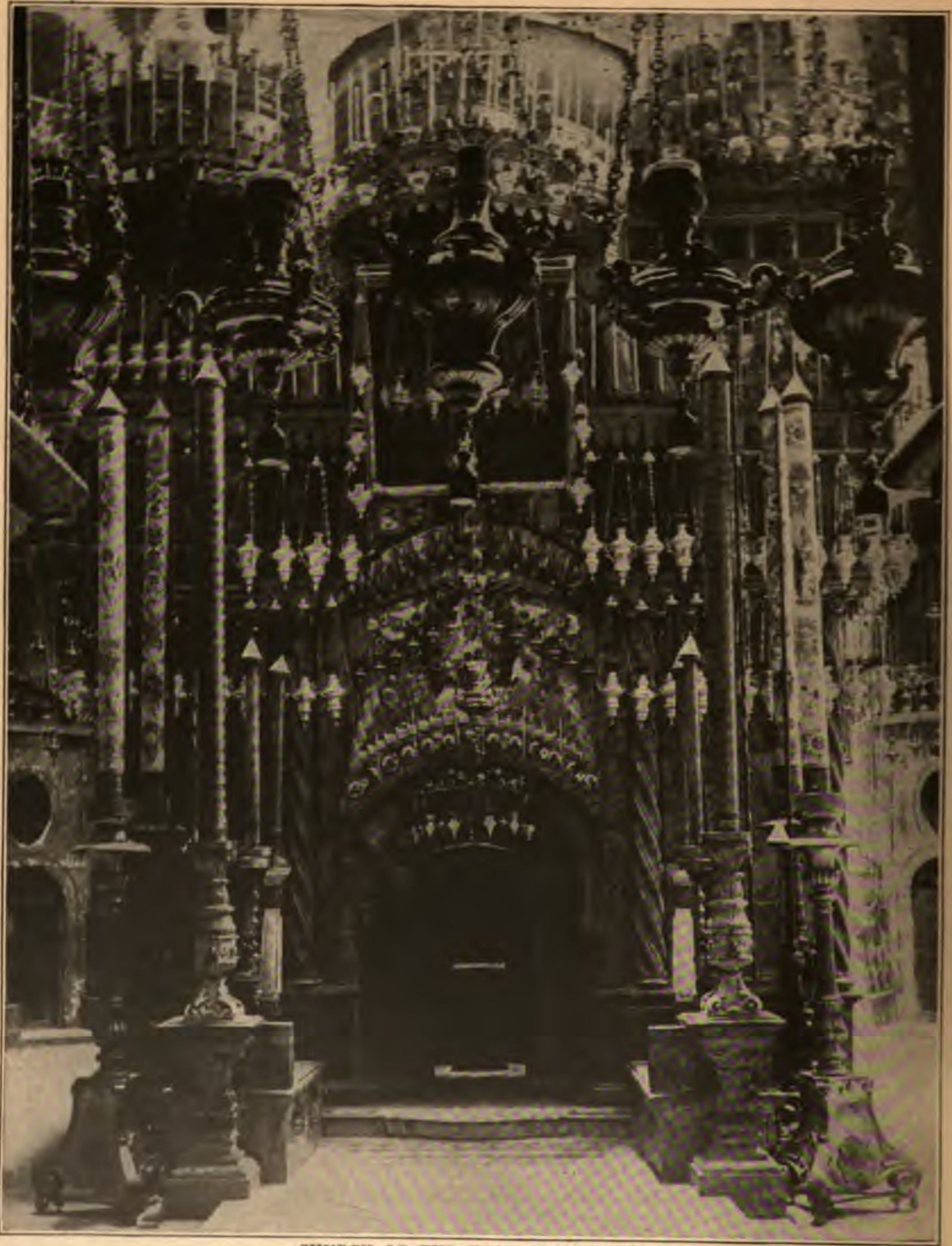
What is serum therapy?

Mention some of the triumphs of modern surgery.

What can you say of the influence of thought on health?

What are the three states of matter?

What is meant by saying "all is relative"?



CHURCH OF THE HOLY SEPULCHER.

The entire Christian world is much interested in the redemption of Jerusalem from the centuries of Turkish misrule. The Church of the Holy Sepulcher covers the traditional site of the tomb in which Jesus was laid. The room shown is circular, 60 feet in diameter, in the center is a highly decorated edifice of marble covering the tomb. Notice the gigantic candelabra in front of it and the innumerable swinging lamps.

STRIKING FACTS OF GENERAL INTEREST

SOME OF THE LARGEST THINGS

To Kremlin, Moscow, belongs the credit of having the largest bell in the world. This bell has a circumference of 68 feet at the bottom, and is 21 feet in height. Its greatest thickness is 23 inches, and it weighs 443,772 pounds. It has never been rung, and was evidently cast where it now rests.

BIG BELL AT CHIONIN, KIOTO.

HIGHEST VOLCANO IN THE WORLD.

Popocatepetl (smoking mountain), 35 miles southwest of Pueblo, Mexico, is the tallest volcano in the world. It is 17,748 feet above the sea level, and has a crater three miles in circumference, and 1,000 feet deep.

LARGEST THEATER IN THE WORLD.

The new opera house in Paris, France, is the largest in the world. It covers nearly three acres of ground; its cubic dimensions are 4,287,000 feet, and it cost about $100,000,000.

LARGEST CAVERN IN THE WORLD.

The Mammoth Cave, in Edmondson county, Kentucky, is the largest cavern in the world. The cave consists of a succession of irregular chambers, several of which are large, situated on different levels. Some of these are traversed by navigable branches of the subterranean Echo river. Blind fish are found in these waters.

THE GREATEST COUNTRY IN THE WORLD.

As you read these pages you should reflect that you are living in the greatest country in the world. There are other countries larger in area; others, more populous; but, all elements of real greatness considered, we surpass any other country. No nation has such a compact national area so favorably situated in a temperate zone, with such a large proportion of fertile soil through which course such navigable rivers. The Amazon River and its tributaries is of course much more extensive but the larger part of its basin is a tropical jungle and centuries must pass before it will be fitted for agriculture and the climate will ever be that of the enervating tropics. As it is the United States is in agriculture, in manufacture, in mining, superior to all others. Africa produces more gold but falls far below the imposing totals of our mining products in value.

FACTS ABOUT GOLD.

All people, as they approached civilization, have had to set aside some commodity to serve as money. The commodity thus selected has varied among different people and at different stages of progress. At one time tobacco was money in Virginia, but in course of time all of the more progressive people settled upon gold and silver as their money metals. The function of money is to serve as the measurer of value, and thereby to further the circulation of commodities. The more advanced commercial nations of today have found it impracticable to have two standards of value, and so gold only has become the standard. It always has been the more important metal of the two.

The function of money in a civilized state of society is so important that all facts relating to the production of gold are of interest. When we reflect that trade, commerce, the circulation of commodities is the life blood of civilization, we can understand the important part these metals have filled in history. This is because they possess in such a great degree the properties necessary for money metals. The student of history quickly discovers that money and general advance in civilization, arts and science go hand in hand.

GOLD AND CIVILIZATION.

At the opening of the Christian Era the amount of gold in the world was the equivalent of about a billion and a half of dollars. Eight hundred years later, at the height of the Dark Ages, that amount had fallen to one-tenth. Here is at least one of the factors which produced the Dark Ages, the lack of a plentiful supply of money, consequently a lack of a circulating medium which carried with it in its flow the commodities of the age, the exchange of which conduces so much to advance human well being. At that point further decline in the stock of gold was arrested by the opening of mines in Saxony and the Harz mountains, the principal source of supply for the next seven centuries. The amount produced, however, was small, only about enough to make good the annual loss. Thus at the time of the discovery of America the amount of gold available for money was only about $175,000,000, only about thirty-five per cent of the amount of gold now produced in one year.

SINCE THE DISCOVERY OF AMERICA

By 1519 the Spaniards had established a trade route across Panama, and a few years later Mexico had been conquered and gold commenced to pass into Europe in increasing quantities. For about twenty years the average production of gold was $4,759,000. That amount seems small, but it was a very material increase over previous production, and it is to be noticed that the modern age of enlightenment was already beginning.

By 1545 the Spaniards had firmly established themselves in South America, and supplies from Peru began to arrive in Europe. From 1545 to 1560 the amount of gold produced was $5,656,000 yearly. But the supply increased but slowly. In 1721 it only amounted to $12,681,000.

For the next century and a quarter, save for the troubled time from 1800 to 1820 when Spain was losing her American possessions, and consequent interruption of mining operations, there was a slow increase in the amount of gold. The increase was fairly proportionate to the general advance of science and national well being. The middle of the 19th century occurred the great gold discoveries in Australia and California. The production of gold was more than doubled, $132,513,000 being produced in 1851. This amount afterwards decreased, but again it advanced, and in 1896 it was $257,301,000.

MODERN PRODUCTION.

The commerce of the world had been advancing by leaps and bounds, and the amount of gold—on which all forms of money rest—was not adequate, and efforts were made to have the United States introduce the free coinage of silver. The effort failed, but fortunately the great discoveries in South Africa, in the Klondike, and improved means of extracting gold by the cyanide process have since resulted in a wonderful increase. $322,619,000 was produced in 1905. The next year it passed the four hundred million mark and has steadily increased, being $423,590,200 in 1918. It has since slightly decreased, but it will probably soon increase. A large part of recent increase has been due to the cyanide process, which makes it profitable to work low-grade ores that previous methods could not profitably use. Such methods are being improved at present. There are today immense deposits of low-grade ores in South Africa and our Western states waiting further improvement in metallurgical process to become available. In the great commerce of the near future increased supplies of gold will be necessary.

PRINCIPAL GOLD PRODUCING SECTIONS OF THE WORLD.

South Africa is now by far the greatest gold producing section in the world. In 1918 it produced 335,464 kilograms of gold. A kilogram is worth very nearly $665. The entire world is interested in the gold supply of South Africa. A great many estimates have been made of future productions. If further improvements like the cyanide process be made, the production will doubtless increase and be abundant for years to come. The United States is second in the list of gold producing countries, producing in 1918 127,000 kilograms; New Zealand third, 30,290; Russia, fourth, 27,084. We are not accustomed to think of Europe as gold producing countries, and yet in normal times that section produced about 35,000 kilograms of gold annually.

PRODUCTION IN THE UNITED STATES.

In 1918 the United States produced 127,000 kilograms of gold valued at $84,456,000. The largest amount ever produced in our country was in 1909, very nearly $100,000,000 worth. Seventeen states, Alaska, the Philippine Islands and Porto Rico contributed to the amount. California comes first with gold to the amount of $20,929,400; Colorado is second with $15,974,500; Alaska, third, with $14,671,400. The production in Alaska will doubtless increase when the government completes the railroads now undertaken. New deposits of auriferous gravels are constantly being found. Throughout the West generally are very large deposits of low-grade ores awaiting further improvements in process. The importance of further improvement is seen when we learn that a large per cent of the total amount of gold now won each year depends upon the cyanide process.

It is a surprise to learn of the production of gold in Virginia and Texas. We do not ordinarily think of gold as one of their productions. As a matter of fact, each of those states produces a small amount of gold. It is more widely known that a number of states along the lower Appalachian Mountain produce gold, and in considerable quantities. The mines in North Georgia have been worked to some extent ever since the Spaniards, under De Sota, traversed the country. From the Appalachian section there is produced nearly $200,000 worth of gold annually.

Considering that the value of the gold mined in the United States is only a fraction of the value of various other minerals; that coal, iron, petroleum each is of vastly greater value; that each of our more important crops far surpass it in value, even the value of the eggs laid each year is far more than the gold mined, it seems strange at first thought that so much importance should be attached to the production of gold. Considerable gold is used in the arts. The unique importance of gold, however, depends on the fact that it has become the money of civilization. Its great function is to further the circulation of all other commodities. The service which gold renders in this way cannot be calculated. Civilization itself depends in no small degree upon it. This statement is true even though civilization may yet invent some form of money that shall be independent of gold.

FACTS ABOUT ALUMINUM.

Next to oxygen and silicon, aluminum is the most widely distributed element in nature. Combined with silicon it is the basis of all clays. Combined with oxygen it forms alumina, and the beautiful gems sapphire and ruby are examples. Emery and corundum are also forms. Its principal source is the mineral bauxite, of which there was produced in the United States 425,100 tons in the last census year. France also produces large quantities.

The element itself has long been known, but it has only been a few decades since we learned how to reduce it from its ores in commercially successful quantities. It is manufactured by electrolysis. The bauxite is melted together with fluoride, which acts as a flux, in a carbon-lined receptacle by the intense heat of an electric furnace, which is an example of the utility of that form of furnace. A current of electricity is sent through the melted mixture. The oxygen of the alumina is given off, the aluminum itself sinks to the bottom and is easily drawn off.

As a metal, it is bluish-white in color, with a specific gravity of 2.5. It ranks with iron in strength, with gold in malleability and ductility, and is almost nontarnishable from exposure to water or weather. It forms alloys with other metals—with copper it forms a series of aluminum bronzes. Being light and strong, it is an ideal metal in automobile and aeroplane construction. It is difficult to see how nagivation of the air could have been made a success without the use of aluminum. It is extensively used for table ware and kitchen utensils. Its production is rapidly increasing. Thirty years ago, barely a ton was made, now 50,000 tons are manufactured yearly. The price has fallen from $2.00 a pound in 1886 to about 20 cents a pound in recent years. Future production will doubtless increase. Improved methods of working will be invented and new kinds of ores discovered; in fact, other great deposits of slightly different ores are known at present.

In this connection it is interesting to know that electricity for city purposes in Los Angeles is brought from a power plant 275 miles away, over aluminum wires twisted around a central supporting wire of steel. New uses will continue to be found for such a serviceable metal.

FACTS ABOUT WATER.

Water is found in four separate states or forms, as ice, water, vapor, and in combination with other substances. As a rule, all bodies contract in cooling, but water increases in bulk and becomes lighter as it gets cooler.

Although water in freezing becomes intensely cold, cold water and cold sulphuric acid mixed in certain proportions, become intensely hot.

IN THE FORM OF VAPOR.

Water is heavier than air, and yet, mixed with the air in the form of vapor, it occupies a space 1,400 times greater than it did in its ordinary liquid state.

A cubic inch of water will make nearly a cubic foot of steam.

Water in the shape of steam at low pressure will scald and blister the hand, but at high pressure, and with double heat, it will not scald or blister.

WATER FROM THE THAMES.

Under certain circumstances water will change its condition without any apparent cause. Ships leaving the port of London take their water from the Thames, and it is said to have some peculiar properties which render it fit for long sea voyages. After a few weeks, or less, it turns putrid and offensive; then it changes its character altogether, becomes pure and palatable, and is better than any other water for sea stock.

THE RHONE WATER.

Water from the Rhone, if allowed to settle and then put into earthen vessels, will remain fit for use a long time. In imperial Rome there was a good supply of water. The allowance for each inhabitant was 300 gallons daily.

CROTON WATER.

Croton water (New York) is remarkably free from impurities, as it contains less than five grains of organic and inorganic matter per gallon; the water in Philadelphia contains less than four grains.

SPRING WATER IN PORTUGAL.

In some parts of Portugal the spring waters are so hard as to be quite useless for many purposes.

WELL WATER IN EDINBURGH.

The well water in Edinburgh is so soft that soap may be dissolved in it, and it will still remain transparent.

Water is liable to become contaminated by lead, and cases of lead poisoning often occur when lead in water is exposed to the air. The carbonic acid of the air attacks the lead and water, acting upon it in that state, makes the lead soluble. Water conveyed in leaden pipes to a fish pond will kill the fish.

EFFECT OF ELECTRICITY ON MILK AND MEAT

During serious electrical disturbances in the atmosphere, it well known that beer may become "hard," milk may go sour, and meat may frequently "turn." Considerable speculation has arisen as to the cause of this. It has been suggested that an ozonized state of the air due to electric discharge has something to do with it, or that the formation of nitrous acid in the air is responsible for the change. It is, however, not probable that the atmosphere undergoes any chemical change sufficient to account for the extent to which certain foods "turn." Moreover, any important quantity of ozone or nitrous acid would be calculated to exert a preserving effect, as both are powerful antiseptics.

It may be urged, again, that the phenomenon is due to oxidation by means of ozone, but this can hardly be the case, in view of the large quantities of beer and milk that are soured, in relation to the very small quantity of ozone which a thunderstorm produces. In the case of meat, at any rate, the "turning" can scarcely be attributed to the action of the ozone or of oxygen. The change is probably due not directly to chemical agencies, but, purely, to a disturbance of the electrical equilibrium.

THE FORCE OF INDUCTION.

It is well known that an opposite electrical state is set by induction, so that an electrical condition of the atmosphere induces a similar condition, though opposite in character, in objects on the earth. Persons near whom a flash of lightning passes, frequently experience a severe shock by induction, although no lightning touches them; and in the celebrated experiment of Galvani, he showed a skinned frog in the neighborhood of an electrical machine, which, although dead, exhibited conclusive movements every time that a spark was drawn from the conductor. In the case of milk "turning," or beer "hardening," or of meat becoming tainted, it is probably, therefore, an instance of chemical convulsion, or, it may be, of a stimulus given to bacteriological agencies set up by an opposite electric condition, induced by the disturbed electrical state of the atmosphere. Although these charges are most marked during a thunderstorm, yet, undoubtedly, they occur at other times, but not to the same degree, when there is no apparent electric disturbance.

ELECTRICAL TENSION.

But even when the sky is clear, the atmosphere may exhibit considerable electrical tension. The electroscope constantly shows that a conducting point elevated in the air is, as a rule, taking up a positive charge of electricity, the tension rising with the height of the point. This effect increases toward daybreak until it reaches a maximum some hours after sunrise. It then diminishes until it is weakest a few hours before sunset, when it again rises and attains a second maximum degree some hours after sunset, the second minimum occurring before daybreak. There are accordingly constant changes of electrical tension going on,—changes, however, which are more rapid and much more marked during a thunderstorm, and which are quite powerful to exert an evil influence on certain articles of food or drink susceptible to change, notably meat, milk and beer or cider.

HEADACHE, ETC., DUE TO METEOROLOGICAL DISTURBANCES.

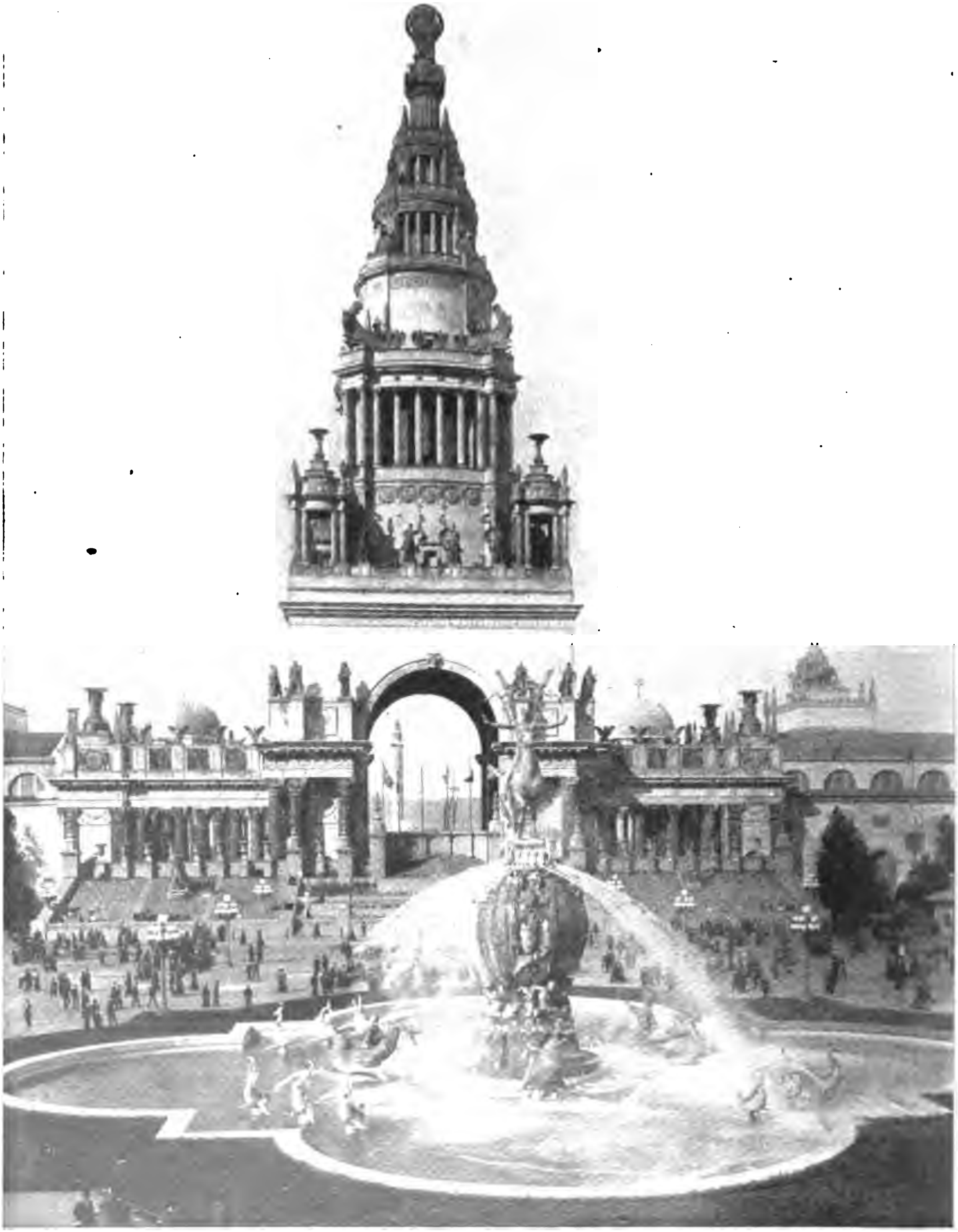
There is no doubt that the unfavorable effects on the feelings experienced by many individuals, such as headache, oppression and nervous distress, on the advent of a thunderstorm, have a similar foundation and are due to the same electrical differences of potentiality, the effects passing away as the disturbed condition of the atmosphere changes, or the storm subsides.

BIRD RESERVATIONS.

Bird reservations are areas in the United States set aside as a home for wild birds, where they can nest and breed, free from molestation by lawless hunters. In this instance, the birds made their selection first, and our government, anxious to protect them and to prevent their extinction, has confirmed them in their ancient rights. There are 56 such reservations, varying in size from an area of but two acres, as Pelican Island, Florida, to reservations of many thousand acres, as Niobrara Reservation in Nebraska, possessing an area of about 12,000 acres. Another immense reservation is in the Delta of the Yukon, Alaska. It is the nesting ground for wild geese, ducks and other water-fowl. The Hawaii reservation, while not large in area, covers a number of islands scattered along five degrees of latitude and twenty of longitude, thus covering an ocean area of considerably more than 175,000 square miles. In general, these reservations are small islands and marshy expanses, as in the Gulf sections—Florida and Mississippi—or small lakes—as in the Stump Lake Reservation of North Dakota—such reservations are for various aquatic birds, such as gulls, pelicans, terns, etc. The great reservation in Nebraska is for prairie chickens and sharp tailed grouse, while sea birds of all kinds are protected in the Hawaii reservation. Recently immense areas have been purchased in Louisiana and set aside as a bird reservation.

FACTS ABOUT INTERNATIONAL EXPOSITIONS

An International Exposition is the final development of the great fairs of Antiquity. Their object is however far wider. It is not to sell goods so much as to acquaint the various nations of the world with the general advance in science and arts and the practical applications of inventive genius in the various departments of industrial life. For this purpose, the nation holding an exposition generally chooses some date commemorative of some event of interest in their national history. Then an appropriate site is selected, many buildings are erected for exposition purposes, foreign governments are invited to participate. Their merchants and manufacturers send specimen of their wares, and the principal nations generally erect national buildings that are in a way typical of their architecture where their citizens who attend the exposition can make themselves at home.



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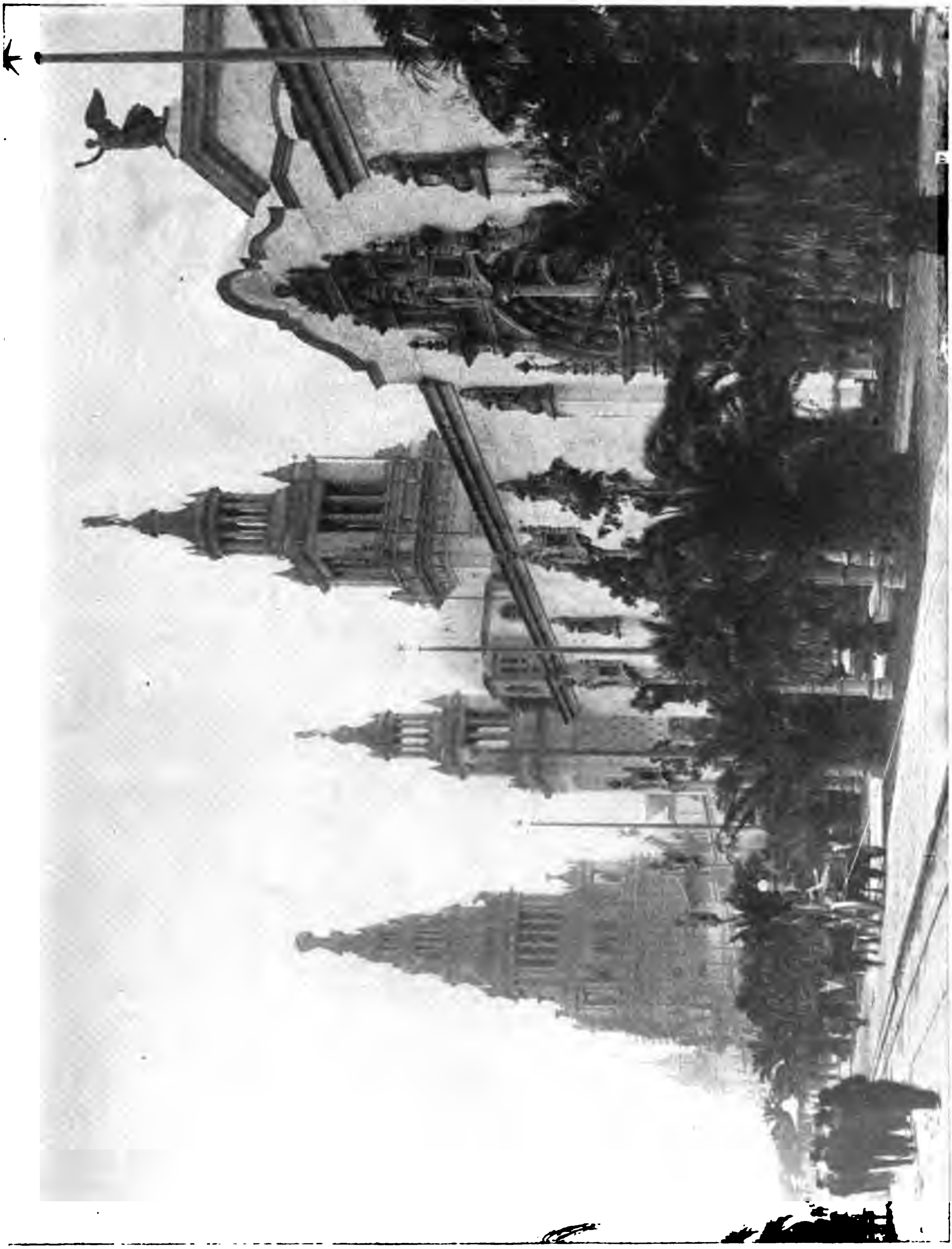
THE TOWER OF JEWELS.

The tower was 433 feet high, adorned with thousands of prismed glass jewels. In the foreground is seen the Fountain of Energy; in the distance through the arch the Tower of Progress. The arch formed the principal entrance to the Walled City.



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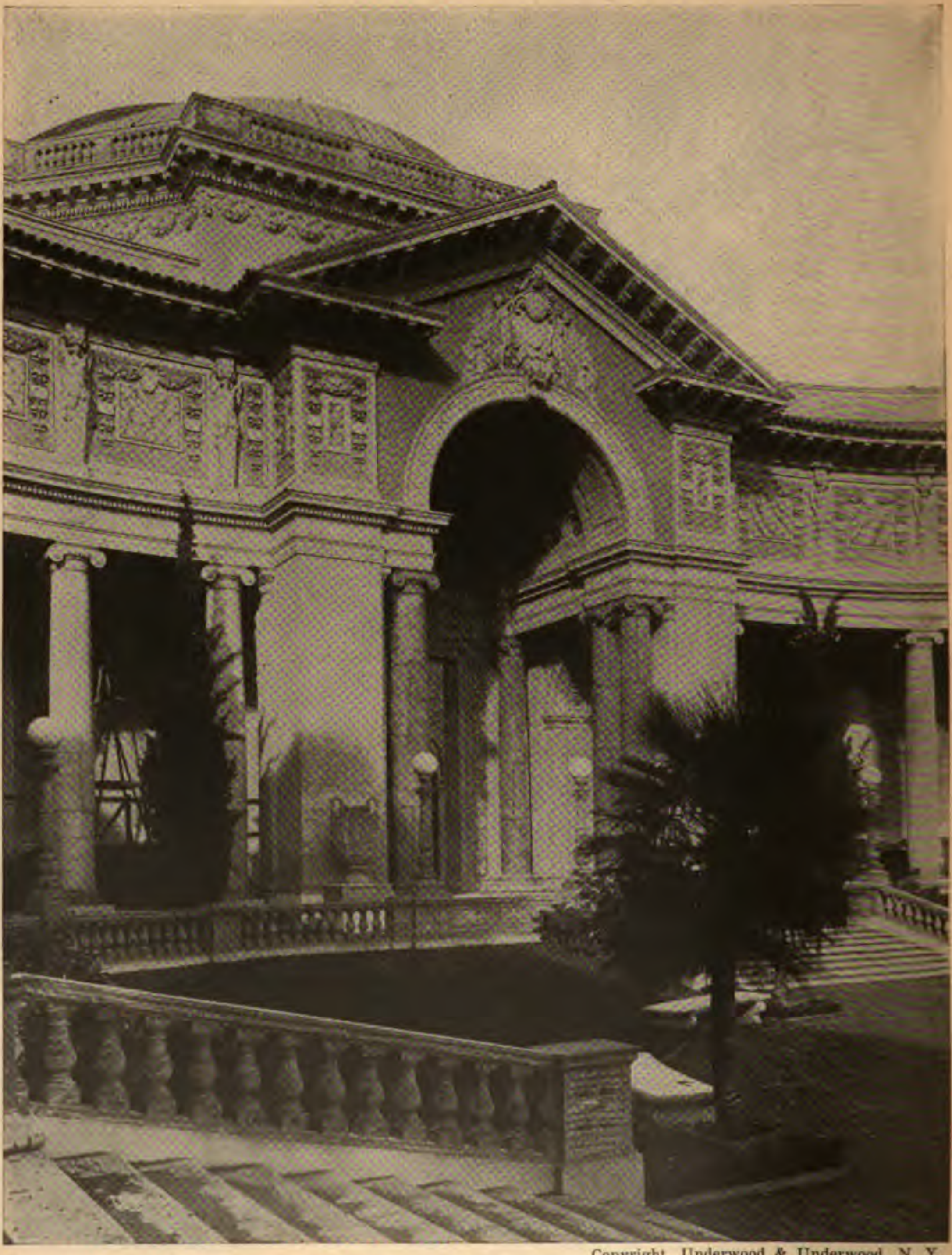
THE AVENUE OF PALMS.

The Tower of Jewels on the left, Palace of Varied Industries on the right. The two towers on this latter building were known as the Italian Towers.



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ENTRANCE PORTAL TO THE COURT OF FOUR SEASONS FROM THE COURT OF PALMS.

All these buildings were of wood, overlaid with staff plaster, in imitation of marble. The general effect was very striking.

UNITED STATES INTERNATIONAL EXPOSITIONS.

In 1876 the centennial anniversary of the Declaration of Independence, the United States fittingly commemorated the same by an international exposition at Philadelphia. In 1893 on the occasion of the 400th anniversary of the Discovery of America, another exposition was held in Chicago. In 1903 the Centennial of the Louisiana Purchase was celebrated by an exposition held at St. Louis. It will be noticed that each of these expositions commemorated an event of great historical interest. In each, foreign nations participated and the distinguishing features of the industrial, scientific and inventive spirit of the age as displayed in all the principal nations were set forth.

PANAMA-PACIFIC EXPOSITION.

Each of these expositions was a great success. The nations of the world became better acquainted with each other, and it was more generally known what each had to contribute to the general increase of national well being and enlightenment. In 1915, our country held an exposition in San Francisco which excelled in every factor that makes such events successful. The date was a slightly delayed 400th anniversary of the discovery of the Pacific Ocean by Balboa; but its main object was to celebrate the completion of the Panama Canal. Ever since Balboa waded into the ocean at San Miguel Bay, statesmen of Spain, of Europe generally, of France in particular and lastly those of our own country eloquently dwelt upon the political importance of a canal across the isthmus. Engineers had surveyed—plans had been drawn, attempts at construction made, and finally the United States had successfully accomplished it. All far-seeing statesmen know that this achievement constituted one of the greatest steps advancing international well being ever taken.

The views we present enable us to form a clear mental picture of the imposing buildings erected on the grounds to add to the pleasing effect. Such buildings are of an historical or educational value like the Tower of Jewels. The statuary and fountains that embelish them are symbolical in character. The effect sought is to emphasize the lesson of the exposition. In this particular exposition the design was not only to commemorate the discovery of the Pacific Ocean but the wonderful development of America since that far-away time.

FACTS ABOUT OSTRICH FARMING.

Such is the extreme limits of climate in the United States that we introduce animals and plants from other lands knowing that in some portion of our area we can furnish them a suitable home. Thus we have introduced reindeer in Alaska, and in our warm and arid sections of the Southwest we have introduced two animals from the hot and arid sections of the old world. Probably few know that a serious attempt was made to introduce camels, on the arid wastes of Nevada and New Mexico. But the venture was not a success, though for some years wild camels were frequently encountered on the half desert areas of that section.

The ostrich, however, proved a success, and considerable attention has been bestowed on their care. The ostrich is a native of Africa, being found from the Desert of Sahara, now a French possession, to the British possessions in the South. But it is a desert bird and is not found in the forests and fertile sections of Central Africa. All are familiar with the general appearance of these ungainly birds. They are the principal surviving representatives of several classes of large birds that flourished in earlier periods of the world's history, just as elephants are the modern representatives of the enormous mammoths of former ages. Ostriches are generally timid, but sometimes they show fight and then they are dangerous adversaries. They can deliver as strong a kick as a horse and the nails on their toes inflict dangerous wounds. When they get fairly going, the speed with which they can travel is remarkable; few horses can overtake them. They are not at all choice in their diet and about all that comes their way is food.

OSTRICH RAISING.

OSTRICH FEATHERS.

The value of an ostrich when kept for profit is in the graceful feathers with which womenkind delight to ornament their hats. It is said that a full grown male ostrich will yield about a pound of first-class feathers at a plucking, which, while the price varies, is worth on an average about $200. When fashioned into plumes, they are worth far more than that. In South Africa, where the birds are extensively raised for their feathers, the latter constitutes one of the principal articles of export, and in the last census year, $11,265,700 was exported, an amount exceeded only by gold, diamonds and wool. Pasadena, California, is the pioneer and center of ostrich farming in the United States.

Of late years, however, southern Arizona and Nevada have taken the lead. What is said to be the largest ostrich farm in the world is in Nevada. Owing to the fostering care of man, ostriches will probably escape the fate that befell other species of large birds in earlier times. Nature seems to have experimented in making large animals until convinced that it was not size that counted in the long run so much as brains. The ostrich is very large and very strong but is not noted for its sense; but for the sake of its feathers it is protected by man.

ATHLETIC SPORTS OF TODAY

In the matter of athletic sports by which both exercise and enjoyment are obtained, America holds the lead. So important have exercises become to perfect the condition of the human body, that all colleges now maintain departments of athletics in which sports are systematically taught. Great rivalry is developed between the different teams of the various institutions. Probably the most popular sport in college circles of the present time is foot ball, although base ball has long been considered the national sport. Golf, of late years, has assumed a position of great prominence, and tennis, polo, lacrosse, basket-ball, rowing, running, jumping, pole-vaulting and many other sports are very enthusiastically followed in student life.

FOOT BALL—CHICAGO UNIVERSITY.

FOOT BALL.

Foot ball is so well known that it is almost needless to describe it at length, and yet a few words may be said of the most complicated of the several games, Rugby foot ball. This game is played between opposing sides of eleven men each. These men fill positions as follows: Center rush, the man in the center of the "line"; right and left guard, men on either side of the center rush, who assist him in his work; right and left tackle, men who occupy positions to the right and left of the guards, and right and left ends, who occupy positions at the ends of the line of players, and next to the tackles. Behind the line and immediately back of the center, is the quarter-back, while near him are the right and left half-backs and behind them all the full back.

Two elevens are drawn up face to face. One of the teams, by toss-up, has secured the ball, an oval-shaped affair, of pig's skin, which encloses an inflated rubber bag. The object of the play is by a series of kicks, punts, rushes, or runs with the ball, to send it from the center of the foot ball field to the enemy's goal line. At the opposite ends of the field are sets of two high poles crossed by a central bar. These are the goal posts. When occasion presents, the ball may be kicked over this goal, thus making a score, but more generally the play is for a touchdown, that is, carrying the ball over the enemy's line and touching it down in that territory.

STEEPLE CHASE.

Numerous trick plays and formations are used to send the ball from one end of the field to the other. The play is very rough at times, because of the scrambling to prevent the ball from being put in motion. To avoid danger, the players pad their clothing and use great head guards and shin guards of leather, and nose guards of rubber. Every year many players are seriously injured at the sport, and many people decry it as brutal. The players themselves, however, its most ardent supporters, maintain it is a grand, healthful and not necessarily dangerous game. Great rivalry exists between the teams of the great universities and colleges. The great foot ball day of the year is "Thanksgiving day," when every college team in the land plays great and exciting games.

BASE BALL.

What person does not know base ball? The smallest urchin seems born to a knowledge of tossing and batting a ball. The national game is still so popular that several leagues, of many clubs each, are given good support in their public performances throughout the summer and fall months.

GOLF.

Golf has been the craze in fashionable circles of late years. This game consists of knocking a small gutta percha ball across specially prepared fields, called links. The course of the field is arranged with a number of holes at greater or less distances from each other. The player, using one of a set of numerous kinds of specially prepared clubs, drives the ball from hole to hole, the one who covers the course in the fewest number of strikes, winning. In order to make the sport more exacting, hazards are interposed on the links. Huge banks of earth and grass called bunkers, ponds of water, and other hindrances so that where the ball will have to be driven far and swiftly, make up these hazards.

BASKET BALL.

Basket ball is a great indoor sport, played principally during the winter months. The game is to drive a large inflated ball by

GOLF—THE FAVORITE GAME TO-DAY.

SURF BATHING—NEW JERSEY.

throwing and bouncing to the enemy's goal, which consists of a sort of basket suspended about nine feet in the air.

This game is often very exciting and nearly every college and athletic association has a team. The game is very popular in women's colleges, which have teams of great merit.

WATER SPORTS.

Water sports continue to be followed by athletes who live near bodies of water. The great Henley sculling matches on the Thames river, of late years, have been participated in by American college teams, with victory frequently perching on the American banners.

MOUNTAIN CLIMBING

This form of sport can only be indulged in by those who have wealth and leisure. Switzerland has been the location most generally selected, and there mountain climbing has been reduced to a science. The peaks most generally selected are Mt. Blanc and the Matterhorn. The dangers of the attempt are so great that no tourist dreams of undertaking it without a guide, neither would the authorities allow him to do so. With all precautions taken, accidents very often happen, and tourists and guides are dashed to death. The guides are trained for the work by long years of apprenticeship; they know every foot of the way and all the dangers of the trip. There are certain places where even loud talking is forbidden, for the echo might start an avalanche that would overwhelm all in its course. Guides and tourists are roped together, with the most trusty guides in advance, cautiously feeling their way, step by step, each one carefully stepping in the footsteps of the one ahead, those behind, with iron pointed Alpenstocks, and tense muscles are braced for a possible shock in case one of the leaders should slip or should suddenly step in some yawning crevasse, which freshly fallen snow

MOUNTAIN CLIMBING IN SWITZERLAND.

conceals. Then the safety of all may depend on strength of muscle, coolness of brain and readiness for action of the guides in the rear. But mountain climbing, whether as exercise or sport, strengthens every faculty of mind and body. It is estimated that 100,000 tourists visit the Alps every year.

In our own country we have notable mountain peaks of the Rocky Mountains that have not been, as yet, successfully scaled.

MODERN WAY OF OUT-OF-DOORS RECREATION

Courtesy of Hendee Mfg. Co.

New Scenes and New Delights from Nature's Bounteous Store.

In this automobile age forms of out-of-door sports so much in favor years ago have found a formidable rival in the automobile tours. The wanderlust is strong within us all, and the craving to go somewhere, anywhere, away from the scene of daily grind, takes possession of us. Formerly it took the shape of summer excursions to the lake or sea shore, to Niagara Falls or Mackinac, or perhaps a Cook's tour to Europe. But now the "See America first" idea prevails and what better way of seeing our country than a pleasure jaunt in a horseless carriage. No "all aboard," no clanging bells or discordant whistles, no traveling by timetables, but a spin, leisurely or fast as your mood requires, along some of our splendid highways through charming scenic surroundings,—distant mountains, swift flowing rivers, wooded hills,—dining at some wayside inn, or camping where the hill and valley meet. A few days or weeks of this takes away "that tired feeling" and we are ready for our work again. The good roads movement is not simply to get more farm produce to market but to get people out of doors. Congress has set aside immense areas possessing the greatest combination of charms to be the inalienable property of American citizens. They are ours to enjoy and the auto excursion is one way of doing it.

HEALTH AND MUSCLE

Well-developed men are to be envied. They invariably enjoy splendid health. There are many ways of exercise which do much to make the physically perfect man.

Too often the abdominal muscles are neglected or exercised only perfunctorily. As a result, the blood in the abdominal region becomes sluggish, for blood does not flow with health-giving quickness unless it receives aid from working muscles. Muscles that are dormant retard the blood's flow, and slowly moving blood does not properly purify the body. Therefore, when the blood in the abdominal region becomes sluggish, indigestion, constipation, biliousness and other and more serious abdominal complications are the result.

All of these ailments are more or less pronounced demands of the abdomen on its possessor to take proper care of it, and proper care means nothing more nor less than a few minutes' exercise of the abdominal muscles after getting up mornings, and before going to bed. The man who will give attention to his abdomen will be amply rewarded. Instead of suffering from indigestion, he will be blessed with a digestion that will compare favorably with that of an ostrich. He will forget what stomachache is like, his liver will refuse to make him bilious, and, in short, all the organs in the lower half of the trunk will perform their functions happily, as nature intended.

Then, too, sturdy abdominal muscles contribute largely to the correct carriage of the body. If these muscles are not strong, the abdomen cannot be held in, and a protruding abdomen has a marked tendency to cave in the chest and twist the spine out of shape. In brief, a man who permits his abdomen to protrude, cannot stand erect, no matter how hard and long he may try. Every sane person admits that proper poise is absolutely and unequivocally necessary to good health; therefore, every well-balanced mind cannot disregard the necessity that the abdominal muscles, so necessary for correct carriage, should be sedulously exercised.

Healthy abdominal muscles also help to develop the chest. When breathing, the further one can pull in the abdomen the greater will be the lung expansion. The stronger the abdominal muscles, the further in goes the stomach, the lungs drink in greater quantities of fresh air, and the blood is furnished with enlarged supplies of purifying oxygen. And everyone knows what oxygen does when it gets into the human system.

A man who exercises his abdominal muscles need not fear that, as he gets along in life, he will annex a "bay window." Fat cannot accumulate in this region if daily exercise is indulged in. On the other hand. exercise will remove fat and restore to men with abnormal abdomens their natural outlines and proportions.

Again, strong abdominal muscles are the best and safest protection against unexpected blows "below the belt." And last, but by no means least, he who gives diligent concern to the muscles under consideration will not become nervous under business stress or from other causes.

EXERCISE I.

Starting with the correct standing position, head up, shoulders back, chest out, abdomen in, arms straight and at the sides of the body, knees and heels touching and toes at an angle of 60 degrees, grasp the left hand with the right, interlocking thumbs and placing the left fingers above the right. Raise the arms above the head, and while doing the exercise, keep them continually by the sides of the head. Bend the body at the hips and endeavor to reach the floor with the fingers. Exhale as you go down, inhale deeply as you come up slowly, and bend back as far as possible. Repeat until tired, then take up another exercise. As the body is bent downward, the lower front muscles of the abdomen and the muscles of the back are developed. As the body is bent backward, the muscles of the back of the abdomen are brought into play.

EXERCISE II.

Raise the arms over the head as before. Turn the upper part of the body noticeably to the right, and then bend the upper part of the body sidewise and down as low as possible. Alternate by doing this exercise to the left. The muscles in the sides of the abdomen are thus developed.

EXERCISE III.

This exercise is splendid for the solar plexus and the upper part of the abdomen. It quiets the nerves and strengthens the diaphragm and its muscles. Lie down on your back on the floor, bend the legs at the knees and draw them up, getting the heels as close to the hips as possible. Fold the arms over the chest, and then raise the head, shoulders and chest from the floor as high as you possibly can, striving hard and ever harder. When at the highest point, hold them thus for a moment, and then lie down and repeat.

EXERCISE IV.

Lie flat on your back on the floor. Put the hands flat under your hips and have the whole upper part of the body relaxed. Then kick with one leg as high as possible and then kick with the other. Alternately kick the legs, keeping both off the floor, and kick rapidly. Be sure to keep the legs straight. When the legs descend from the highest point toward the floor, they should stop about six inches above the floor. This exercise is unexcelled for the muscles in the central and lower portions of the abdomen.

TWO SPLENDID EXERCISES.

And now for two splendid exercises that will prevent varicose veins and build up legs capable of properly carrying the body. Sturdy legs are as necessary to a body as flawless wheels to a locomotive. Don't neglect your legs and thereby put yourself in the way of dangers that may wreck both your legs and your good health.

No. 1.—Assume the correct standing position. Relax the legs below the knees. Then alternately and rapidly, with the leg ascending, bent at the knee, kick the knee up toward the chest, keeping the lower part of the leg well forward. Try hard to hit the knees against the chest. This exercise is beneficial for the so-called kicking muscles, the muscles of the upper leg and thigh.

No. 2—This is excellent for the lower part of the upper leg. Start from the correct standing position. Grasp a stick in the hands, and keep the arms straight and well in front of the body. With the knees and heels together and heels and toes touching the floor, sit down as low as you can. Do this part of the exercise as quickly as you like, but rise up slowly, keeping the upper part of the body erect, as in the correct standing position.

A GENERAL EXERCISER.

For a general exerciser of the entire front of the body—legs, abdomen, chest, arms, wrists and shoulders—lie flat on the abdomen, on the floor, *face down*. Be sure that the body is perfectly straight, the toes touching the floor and the feet close together. Then, with the palms of the hands flat on the floor and the elbows at the sides of the body, fully straighten the arms, and support the body on hands and toes. The body must not be permitted to bend; keep it solid and straight. Hold it thus for a moment, and then bend the arms and let the chest touch the floor. Repeat this until tired.

These exercises, like many others, do much to make the physically perfect man and maintain general good health.

The foregoing observations and instructions are from the pen of Prof. Hamlin Barber, of Boston, Massachusetts.

VENTILATION AND HEALTH

Only within the last few years has the great importance of pure air been understood. It is calculated that to be kept in full health and vigor each adult individual requires 3,000 cubic feet of fresh air every hour. The attempt to make our houses as nearly air tight as possible in winter, by the use of double windows and other devices, is a suicidal policy unless ample provision is made for ventilation in other ways. It makes the inmates delicate and susceptible to the slightest change. They would be far healthier living as our ancestors did in a log hut.

The quality of the air we breathe is quite as important as that of the food we eat. A fire in an open fireplace is a fairly good ventilator, and in dwelling rooms, and especially in bedrooms, the fireplace should always be left unclosed, and the flue or damper open for ventilation. A ready way to ventilate a room is to fasten a neat strip of wood an inch or two wide to the window sill, and extending clear across the window. Fasten a piece of "weatherstrip" on top of this strip, so that it will form an air-tight joint with the lower sash. In this way the lower sash can be raised one or two inches without letting in any air at the bottom of the window, but an opening will be formed at the top between the two window sashes through which a current of fresh air will flow. If a piece of wood or tin be attached to the top of the upper sash, sloping upwards, the current will be directed toward the ceiling, whence it will diffuse itself through the room. To ventilate a room do not rely on getting the air from halls or other rooms, but introduce it directly from the outside. A ready way to ventilate rooms which are much occupied, is to open the windows during the meal time, and before they are needed again they can be rewarmed. The improvement in the air will be very noticeable.

VENTILATION OF SLEEPING ROOMS.

Have the bedroom well ventilated always, and if no other provision is made leave the window down two or three inches at the top. Place the bed where the draft will not strike it, and if there is more than one window, open the one farthest from the bed. If necessary, the curtains may be drawn to prevent the draft from striking the bed. More air will be needed when several people occupy the same apartment than when there is only one. If in the morning the room smells close to one who comes in from the outside, it shows that the ventilation is insufficient; but if no smell is perceptible, the ventilation is good. On completing the morning ablutions, throw the window wide open to thoroughly ventilate the room. Another important matter is to admit the sunlight into all the rooms of the house if possible. Even if it fades the carpets, a little of that is better than to shut it out and have the cheeks of the children fade. An abundance of fresh air and sunlight will save many a doctor's bill, and what is vastly more important, they will preserve the health of the family.

In hot weather, wetting a cloth and hanging it in the window over the blind, will cool and freshen the air greatly—almost as much as a shower. A large sponge hung in a room and kept continually wet will also cool the air, either in the day or night.

IMPURITIES IN THE AIR.

The principal contaminations of air are the presence of poisonous gases due to sewers, etc., and the presence of carbonic acid gas in excess. Wholesome air does not contain above five volumes of carbonic acid in 10,000; as the proportion increases the quality of the air deteriorates, until it becomes positively poisonous. The simplest method of testing the amount of carbonic acid present is by using lime water. This can be obtained of any druggist, but should be freshly made. When lime water is shaken up in a bottle of air containing carbonic acid, the acid combines with the lime, forming an insoluble powder of carbonate of lime, and when this is in sufficient quantity it makes the water turbid or milky, so that it can be recognized by the eye. The test is made by having a series of bottles of various sizes, filling them with the air to be tested, placing a large teaspoon of the lime water in each one, corking tightly, and then shaking them vigorously for three or four minutes, so that all the air in the bottle shall be brought in contact with the lime water, and all the carbonic acid taken up by the lime. In bottles of large size the fluid will become dense, while in those of small size it will remain clear. If a ten-ounce bottle thus shaken becomes turbid it indicates the presence of more than six volumes of carbonic acid per 10,000 of air; while turbidity in an eight-ounce bottle indicates more than eight volumes; in a six-ounce bottle more than eleven volumes; and in a four-ounce bottle more than fifteen volumes. Anything over five volumes should be corrected. There is no test paper which can be made practically useful to indicate the quantity of carbonic acid in the air.

So important is ventilation regarded that all large cities regulate by ordinance the number of persons allowed to work or live in rooms of a given size. In New York City these laws are particularly stringent. They specify what proportion of the ground may be built upon, the minimum size of rooms, and require that 400 cubic feet of air be allowed for each adult, and half as much for each child under 12 years of age.

FACTS ABOUT BATHING.

Hardly anything is more beneficial to the human body than the right kind of a bath at the right time. There are at least a dozen different kinds of baths, and there are conditions of the body when eleven of them may be either of doubtful benefit or positive injury.

HOT BATH FOR CLEANLINESS, COLD BATH FOR TONIC.

Many persons who are physically strong and of regular habits go through life healthfully, taking just two kinds of baths—the hot bath at night for cleanliness and the cold morning plunge for a tonic. Such persons need no advice about bathing.

In the case of children and the majority of adults the other eight or then varieties of bath should be thoroughly understood. There is hardly any remedial agent so speedy and favorable in its action as the cold, tepid, warm, hot, plunge, shower, sponge, pack, foot, or sitz bath intelligently applied.

TEMPERATURE OF THE BATH.

It is mainly a question of temperature—temperature of the body and temperature of the bath. When the temperature of the body is normal and the general health is good, one may safely suit his fancy in the matter of baths, provided he keeps his skin clean and the pores unclogged. Most people know that a cold plunge is injurious only when it overtaxes the resisting power of the bather so that exhilarating reaction does not follow the otherwise beneficial shock. Anyone, however, healthy and strong, may remain in cold water so long that fatigue and even severe prostration result.

THE SHOWER BATH.

Respecting the shower bath, the douche and other baths in which the nude body is exposed to current of waters, there seems to be much popular misinformation. All these baths are exaggerations of the cold plunge and should be used with caution.

THE HOT AND WARM BATHS.

The warm bath is relaxing, as there is no reaction. If prolonged it is enervating, and the same is true of the hot bath. A bath of a temperature above 110 degrees can be borne only a short time without injuriously exciting the heart.

CHILDREN'S BATHS.

Systematic cold bathing is frequently beneficial to children who have a sluggish circulation, with a poor appetite and feeble digestion and who are addicted to colds, but these baths should not be showers or douches except when prescribed in specific instances by a physician. There will be sufficient shock and tonic effect if the child is sponged with cool water in a warm room for not more than five minutes at a time and then dried and gently rubbed.

For children warm baths are valuable to bring blood to the surface when there are spasms, colic or congestion of some inner organ. If there is congestion in the brain, indicated by headache, warm or hot bathing of the extremities of the body will tend to relieve the pain and promote sleep.

When the temperature of the body is

normal, hot or cold baths will neither heighten nor lower it. But when the temperature is abnormally high—when there is fever—it may be brought back toward the normal point by cold bathing. In the absence of medical advice, however, such treatment should be limited to a sponging of the entire body in water whose temperature is not lower than 70 degrees.

THE COLD PACK.

The cold pack is more efficacious in cases of fever than cold sponging, but unless ordered by a physician it should be used seldom, and then with caution. A folded sheet is dipped in water not colder than 85 degrees, and in this the body is wrapped from armpit to ankles, with a blanket for outer covering, and then left undisturbed for ten minutes. Then the patient is taken out of the wet sheet and enveloped in a blanket and allowed to remain quiet.

THE TEPID BATH.

In bathing children no mistake is made in using the tepid bath, of about 95 degrees, which, after the child has been placed in it, may be cooled down to 90 or 85 degrees. On being taken from the bath the child should not be dressed at once, but wrapped in a bath blanket and left there for twenty minutes. This will prevent chilling.

Proper bathing, according to the condition of the body, is almost a fine art, and its value is so great as to make that art well worth intelligent study.

THE EFFECT OF MIND AND BODY.

Health is the greatest blessing, for without it we can not enjoy wealth, education, or position. Outdoor sports and exercise, bathing, and ventilation are of value, as they protect our general health; but we are learning that one of the greatest means of preserving health is within. Long ago, it was written that as "a man thinketh in his heart, so is he," and this has as much bearing on our physical as our moral health. When we fear disease, we more readily fall a victim to it. What is wanted is a calm confidence that the forces of life, as we have described them, are able to cope with all diseases in general, and it is our duty to assist in the work.

Fear and worry are the greatest enemies to health. During an epidemic, people who are susceptible and full of fear, become panic-stricken through the cumulative effects of hearing the subject talked about, and discussed on every hand. Their minds constantly dwell on the disease and its symptoms. The result is inevitable. They become susceptible to the disease itself. It is so with every ill to which we are liable, from taking cold to the most formidable disease. We can best guard against such attacks by guarding the citadel of life itself, that is, our own minds. It does comparatively little good to clean the body by daily baths, if our minds are full of fear. What we must do is to reverse the currents of our thoughts. Of course, use reasonable care at all time, but instead of thinking and talking disease, fill your mind with health thoughts. Know that you are well and strong. You can not be optimistic, full of enthusiasm and courage if you are really sick; the reverse is just as true.

THOUGHTS ABOUT SUCCESS.

One of the greatest blessings that can come to a boy is to be born in the country, reared on a farm, and know from experience what privation and work mean. As a rule, the men who accomplish great things in business and professional life are not far removed from the country; they have either come from there themselves or are the sons of those who passed their early years in the country. There are notable exceptions to this rule as to all others. There seems to be a close connection between robust character and the soil, the hills, mountains and valleys, the pure air and sunshine. The drudgery of the farm often turns out to be the most practical education. It develops power and makes practical men, and self-reliance and grit are more apt to be developed in the country. It has been found that the use of tools in our manual training schools develops all the mental faculties as well. The farm is the best manual training school in the world. This is one of the reasons why the country boy usually develops all-around good judgment and a level head.

USE YOUR PRESENT OPPORTUNITIES.

The greatest success in life is won by those who began by making the most of opportunities around them. And nearly all young men, whether on the farm or in the office, have splendid opportunities on every hand, but they do not know how to utilize them. In our large cities it is found that a very large per cent of all who gain fame and wealth do so by making the best of small opportunities which others do not notice. The scholar who is always gazing at the stars may miss the beautiful flowers at his feet; one who is always looking for some great opportunity passes by many small ones which, if utilized, would lead to great results, just as thousands of men have made a fortune out of what others regarded as trifles. It is not opportunities that are lacking, but the will to make the most of such opportunities as come to all. It is the old story of the faithless steward. It is the faithful performance of present duties, doing your very best in whatever position you may be placed, that is going to win you success. If you fail in life, the chances are nine out of ten that it is not for lack of opportunity, but a failure to use such as you have.

IMPROVEMENT OF SPARE MOMENTS.

It has been truly said that spare moments are the gold dust of time. It is the little savings that make men rich, it is the right use of spare moments that enable men to win education, competence and success. The men who have accomplished great things in life are those who have been saving of their time. One hour a day in a few years will give any one an education that will fit him for life. An hour a day saved might make all the difference between a bare existence and a useful, happy living. An hour a day —and how many waste far more than that every day—might make you famous, a benefactor to your race, a blessing to all. The present time is the raw material out of which you can make whatever you will. Do not brood over the past, or dream of the future, but seize the instant, do your present duty, make the most of present opportunity. Time is money; we should no more waste it than we would money. Waste of time means waste of energy, vitality and character. It is the waste of opportunity which will never come back. By the cultivation of every talent you possess—not lamenting because you lack some great talent; watching every chance of improvement, no matter if they be small; improving every opportunity, no matter how inconsequential it may seem; always doing your best, whatever you are set to do—will enable you to make of your life almost what you will.

RIGHT THINKING.

One reason why the careers of most of us are so pinched and narrow is because we do not cherish right thoughts. Whatever we long for, yearn for, struggle for and hold persistently in mind, we tend to become just in exact proportion to the intensity and persistence of the thought. We think ourselves into smallness, into inferiority, by thinking downward; we ought to think upward, then we would reach the heights where superiority dwells. There is probably no one thing which keeps so many people back as a low estimate of themselves by their limiting thought, than by almost anything else. There is no power in the universe that can enable a man to do a thing when he thinks he is incapable.

THOUGHTS ABOUT HOME

The average theory of home life is that the happiness of home depends almost solely upon the wife and mother; that woman's first and highest mission is her home; that there are no clouds that ever overhang the home that sunbeams, bright and joyous, cannot penetrate. Love and reason, hope and aspiration, blend in a glorious, gorgeous rainbow of promise that arches the holy circle of home.

WHAT HOME MEANS.

Home means much in this twentieth century; it means all that makes life really worth the living. It is the object to which all unselfish endeavor is directed. It is the one solitary spot in the desert of the world where all those principles taught us in childhood preserve their living green, and reach out of the twilight of the past into the sun-gold of the future, preserving unbrokenly for generations to come the lessons therein taught.

THE WORD HOME.

Home is a word that we love to linger on. It brings around our hearts a confiding trust and repose. It has been said that there is no sweeter word in all the dialects of earth than the word home, unless it be the word "Mother," and home always suggests her and clusters about it more happy and hallowed associations than any other place. Its impressions are the strongest, deepest and most ineffaceable. It means life after death, the hereafter, to all who are blessed with offspring, in whom their own characteristics and energies are perpetuated.

It is the golden chrysalis, wherefrom the hope of the future takes wings at last. The home life is the nucleus around which all life has its growth, and that its tone and coloring are transmitted not to one generation alone, but to many generations, is an indisputable fact.

MOTHER.

Some writer has said that each member of the family contributes his or her share towards the making of the home, but the principal, presiding spirit is the wife and mother. She is, or should be, its life, heart and center.

The mother holds the key of the soul, and she it is who stamps the coin of character for her sons and daughters. Then crown her queen of the home. We should make our homes as tasteful as possible and beautify them with all the adornments which nature and our purse can provide. We should adorn our grounds with those natural attractions which the Creator has so profusely spread around us, and especially should we adorn the family circle with noble traits and kindly inclinations, fill the atmosphere with affection and thus induce others to love rather than fear us.

WHAT MAKES AN IDEAL HOME?

The ideal home is not made up simply of furniture and fixtures and decorations. The furnishing may be elaborate and luxurious, the decorations of the most artistic character, the arrangements for comfort perfect in every respect. Still, if it lacks the sunshine and warmth of love and affection it is not an ideal home; it is cold and dull and without life. It is marvelous, too, if the home lacks this element, how soon it will be manifest. The absence of it permeates the very atmosphere. There are homes, however, whose memory is a perpetual joy, and to which we always turn with emotions of gladness and pleasure. Neither statuary nor paintings may grace niche or wall. They are plain and unpretentious, lacking everything but the necessaries of life. Yet they are filled with beauty because of the spirit of love and affection abiding therein.

DUTY OF FATHER AND MOTHER.

It is the duty of every father and mother to make the home attractive. Make the living rooms pleasant, give them the sunniest side of the house. The plant that lives in the shade is sickly and unsightly.

ORDER.

One of the indisputable conditions of a pleasant home is the preservation of order. Have a place for everything and put everything in its place. "Order is heaven's first law." We should cultivate a habit of reading, if we have it not. We need it as well as we need air and sunshine, sleep and food. How refreshing it is to be able to lose one's self, even for a short time, in places where nature reigns.

BOOKS.

The humblest country boy or girl, kept at home by poverty and having to perform menial labor, may, if he will, with the aid of books, use the eyes and ears and brains of all men, everywhere and in all ages.

To-day the whole world of thought is before us and at our disposal, in every city and village, for a mere pittance. Every home should have a library. What bread and other articles of food are to the body books are to the mind, and, as the mind craves knowledge, its wants should be supplied or provided for with great care. A library always affords the choisest companionship. Some books are inspiring. Every page and sentence stirs us to higher motives and a higher life. Others inspire us with awe and veneration as we read them. Others are fragrant; they breathe the air of the mountain, the hillside, the valley, the home. Those who have a well-selected library may dine with kings and reason with philosophers, associate with poets and painters, and number the master thinkers of all ages among their personal friends. A home without books is a dreary, inhospitable place. A good book is always a genial companion. We should select our libraries with the greatest care, beginning them with the Bible, and making the poets our special friends, adding, each year, such books as may come within our reach. This is a sure means of refinement and education.

MUSIC.

The home is almost as incomplete at the present day without some musical instrument, as it would be without books. We should cultivate a taste for music, both instrumental and vocal. Music is classed among the fine arts, and is taught as a science which all may learn. Music has a refining, inspiring and patriotic influence. From the mother's lullaby to Mozart's requiem masses, in the masterpieces of Haydn and Beethoven, we can mark the influence of music. Who has not felt the quickening spirit while singing, or listening to the sweet melody of the gospel hymns? Have we not the testimony of thousands that martial music thrills the soldier with a spirit of bravery on the field of battle?

It has been said that no great musician has ever been convicted of a great crime. Shakespeare, as also well known, makes melodious utterance a test of civilization. Besides bespeaking a soft voice for a woman, he says: ''The man that hath no music in himself, nor is moved with a concord of sweet sounds is fit for treason, stratagems and spoils.''

MUSIC'S MELODIOUS SOUNDS.

We are certainly a music loving people. Let us have it, then, in the home. Nature has done her part generously. She sings to us through warbling birds, and whispering pines, rearing waves and whistling winds. The least we can do is to join in the melody of nature, and by so doing, we add one more to the many bulwarks which should ever protect and surround the home.

STARTING IN LIFE.

The time finally comes to all boys when they must plan for their life work. In the new age now upon us the opportunities indeed are many but no matter what line of activity one proposes to oneself there are certain success factors which must be taken into consideration. The present day comes with opportunities in her hand but they will not be enjoyed unless one is willing to prepare, use judgment in choice and work in earnest.

Distance lends enchantment to the view and this is true in choosing a career. The country boy imagines a great future awaits him in the city and plans to leave his home in the country as soon as possible. It is true that many men who won fame and fortune in the city came from rural homes, but something more is required if one would enjoy the good things of life than early experience in country life. At the bottom one must cultivate those traits of character that make for success.

We can not do better than to devote some time to a consideration of some success factors. They are but few of many that could be considered. It would require a volume to treat of them all. We trust that every country boy who may chance to read these lines will reflect that success in life does not depend upon surroundings but upon character, it springs from qualities within himself.

ONLY THE FITTEST SURVIVE THE STRAIN.

Unless the boy from the country is the possessor of rare qualities, city life is likely to prove to him a delusion and a snare. Only the fittest, in such a change, can survive the strain. As a rule, the youth bred to city life is much more likely to succeed than his country competitor for a job, because he is imbued with the push of the bustling mart, and is thoroughly familiar with the surroundings. He is, moreover, less liable to succumb to the temptations that hedge about him because he is safeguarded by the attractions and restraints of home.

Let the country boy, except in rare instances, stay at home, at least until he has saved enough of his sure earnings to begin mature life in an independent way. Let the country boy remember that the country is better far than the great metropolis, for mental and moral development, and for the establishment of strong individual character. The country, and the small town (not the city) give to the nation its towering celebrities. What great scholars, orators, theologians, scientists, lawyers, or statesmen have sprung from the environments of a great municipality? Let the wise country boy be mindful of these things, and stay where he is until he has laid the foundation of a successful career.

FACTS ABOUT LETTER WRITING.

Letter writing will soon be numbered among the lost arts. It has come about through the increase in postal facilities that we have to write so many letters that we do not care to spend overmuch time on any one, or any series. The modern methods of travel which seem to have annihilated distance, have given to correspondence less importance in our eyes than it formerly had.

SCRIBBLING LETTERS COMMON.

People no longer write letters; they scribble them. But what others do in this connection is, or should be, nothing to you. It is your creed that all things should be done well. In letter-writing, particularly, you will take great pride and pleasure. Your letters stand for you. You do not enter a friend's house, utter half a dozen poorly expressed commonplaces, and then depart. Nor should your letters show as little care. Representing you, they should show you at your best. The envoys of your love, your friendship and your interests, you should see to it that nothing about them is disappointing.

THE LETTER A MESSENGER OF ITS WRITER.

Every one of them has need to be a worthy messenger, now to console, now to amuse, now merely to pass the time of day. There is no present so sweet to receive as a beautiful letter. In your letters trivialities may have ample room. To those you love, they are very pleasing, running over with such little details as correspond with chattering,—little details,—the unimportant things that separation makes important.

THE HEART SPEAKS.

Nothing more is required than that your heart should be in the matter. "The scholar sits down to write," says Emerson, "and all his years of meditation do not furnish him with one good thought or happy expression; but it is necessary to write a letter to a friend—and forthwith, troops of gentle thoughts invest themselves on every hand with chosen words."

GLOW OF AFFECTIONATE LETTER.

An affectionate letter! What a glow it leaves in the heart! It is a disappointment when the postman passes the door. But to take pleasure in receiving letters is not consistent with a neglect in writing them. To be sure, they take up much time. But it seems very certain to you that the time is not wasted. It is so much pleasure that you can give away at the cost of a little red stamp. You make your letters members of your life. What you do, what you are, what you think,—that you set down, and all else that comes into your head. Your letters are very intimate.

A GOOD LETTER MIRRORS THE MIND.

A good letter is the mirror of the mind. It is something that flashes. It is an epigram. Herein lies not the least benefit of letter writing—that many things must be set forth in so small a space.

SPONTANEITY IN LETTER WRITING.

Letters are never so charming as when they are written spontaneously—when they arrive unexpectedly. Letter writing is hard work, and the mood for hard work is illusive. Practice writing; make your letters characteristic of yourself always.

COURTESIES OF LIFE.

In the present scramble for wealth, position, rank and recognition, we are fast losing sight of the more important courtesies of life. The future of our families and, incidentally, the well-being of our old age depend more on our home existence than upon any advancement we may make in the different enterprises which occupy the minds of men.

AMENITIES OF HOME LIFE.

If some are indifferent enough to popular opinion to devote more time to the civilities of their homes than is the general custom, let us recognize the fact that their judgment is nearer right than that of others who are more prominent. While we must acknowledge the great social good accomplished by those who strive in the interest of the public, we must admit that the most useful sphere for American mothers and, in most cases, daughters, too, is the home.

FAMILY TRAINING.

Primitively, woman was a helpmeet, a complement, not another self—the two parties to marriage filling their respective spheres, forming a perfect union, and yet with each one's work impossible to the other. In spite of all contrary opinion, woman's highest mission is to guard the sacred precincts of the home, for, before any other training whatever, comes the family training,—that preliminary training in which correct personal habits, respectful treatment of elders and superiors, obedience to authority, courtesy and morality are inculcated. Freedom from home control in the young is painfully evident, showing the need of a closer watch and guard over the domestic circle, and the imbuing of offspring with a greater regard for parental authority and parental judgment. Children speak to their parents and act toward them in a manner that would have been shocking a few generations ago.

Many parents fail to exact the courtesy due them from their children, fearing that the child may consider it a vain assumption of dignity. This negligence is followed by a less respectful demeanor toward father and mother and those in authority. Courtesy, or true politeness, is not a garb to be put off and on at will. On the other hand, it improves with use.

If we daily maintain the courtesies in home life which we extend to associates and acquaintances, our politeness in social circles would not savor so much of affectation. Chesterfield advised his son to use good grammar even when talking to his dog, in order to acquire the habit of correct expression. It is well to observe this rule with all the minor attainments which go to make us agreeable. Unless we respect ourselves enough to practice the common civilities, we cannot be anything but brusque and impolite. Our manners are often self-conscious, crude and vulgar. "If they don't like my way," says one, "they can take the less of it." Until such misdirected individuals enter into a circle the manners of which are more reserved and refined than their own, they have no realization of the fact that their ways are unacceptable, or that they are different from those of more agreeable people.

Brusqueness is not always manifest in what one says, so much as in the manner of speaking of an ordinary matter, or in an abrupt entrance, a disrespectful or lounging attitude, or a noisy salutation. "Every heart knoweth its own bitterness," says the Holy Writ. And it is an unpardonable familiarity, and also a display of egotism, to inflict upon others a minute description of the details of one's own small affairs.

SINCERITY AND KINDLINESS.

Anybody can recapitulate the troubles of the shop, of the kitchen, the nursery and the petty grievances of the neighborhood. We must learn to take human nature as we find it, and, at the same time, search for the brightest and best qualities among those with whom our lot is cast. Good will to our fellows and sincere motives should be the underlying principles which govern our intercourse with mankind. It is no hard task to cultivate a kindly feeling for others. There is no veneer that will stand the test of time. Our shallow courtesies may please for awhile, even if but occasionally assumed; but, in an unguarded moment our rougher self is revealed. The only solid basis of true politeness is the possession of right principles and virtuous character, the leading of a true life. Natural kindliness of heart and sincerity of intention must be back of all our actions. Unfeigned courtesy is best acquired and maintained in the daily intercourse of our homes.

PUNCTUALITY.

Punctuality has been defined as being "the politeness of kings," but it should not be confined to royalty. It is politeness on the part of all. Every time you are late in keeping an appointment, unless unavoidably detained, you are guilty of a breach of good manners. You may have a right to do what you will with your own time, but you have no right to subject others to a possible loss of time, for it cannot be too often repeated that time is money, and by your carelessness in this respect you take from them that which is of value.

Few people who are habitually late in keeping appointments realize what a source of worry this habit is to their friends; they may condone, but the business world does not overlook this fault, and the failure of many young men can be ascribed to the habit of being always a few minutes late. By a mistaken process of reasoning, they persuade themselves that such a habit is a mark of a very busy man. Some of them make a point of being ten minutes late for everything, others are half an hour late, but they are regular in their tardiness that it amounts to a species of punctuality.

PUNCTUAL BUSINESS MEN.

The successful business men are always noted for their punctual habits; they are never intentionally late at a business appointment. Young people desiring success should follow such examples, instead of worrying about the pattern of his or her clothes, as some of them do.

FEW LATE FOR A TRAIN.

It is a notable thing that hardly anyone is late for a train; it is one of the rarest things in the world for a train to be missed. This, in itself, speaks volumes, for does it not show that even the most dilatory of mortals can be in time if they so choose?

A NUISANCE AT THE THEATER.

The same people, however, think nothing of coming into a theater after the play has begun. They will arrive long after the curtain has gone up, talk about programmes, argue as to who shall sit in a certain seat, divest themselves of cloaks and coats, and generally take some minutes to settle themselves down, to the extreme annoyance of all the unfortunate beings around them. Their conduct is quite as disconcerting as that of the wearer of the matinee hat.

LATE FOR DINNER.

There are other people who are always late for dinner, whether at home or at a party. They make no apology whatever. We all know the people who sail in at a large dinner party 20 minutes after everyone else has arrived, and appear quite smiling and thoroughly pleased with themselves. They seem far from realizing that 18 hungry people have been waiting their advent, and that the host and hostess have been in an agony of suspense, for, all entertainers are not wise enough to go to dinner without waiting for such remiss guests. The late comers are quite oblivious of the fact that the culinary department has been watching minute by minute, while a good dinner was spoiling. From 20 to 30 people have been annoyed and upset by the selfishness of these tardy ones, who, quite unruffled, ignore the fact.

Surely, it is quite permissible for the dinner to be served ten minutes after the appointed time, so that those who are courteous enough to arrive at the right hour may not be punished for the heedlessness of others less punctual. If a few more hostesses,—for there are some who do,—showed their sense in this way, lateness would go out of fashion.

It is an odd thing that the people most accustomed to dine out are the most punctual, just as it is that the people who receive the largest number of invitations are the most punctilious in answering them.

A PROBLEM OF 20 INVITATIONS.

Suppose a lady sends out 20 invitations for a dinner party. She may invite six couples; then, four unattended gentlemen and four unattended ladies are needed to make her party complete. Every hostess knows bachelors or maids, widows or grass widows. Some of the invitations will be answered with true courtesy by return post; others will remain unanswered for days. The lady's table will accommodate but 20 guests; she likes to have her full complement; but she cannot ask more than that number, in view of the possibility of some one declining, for should all accept, the limit of her facilities would be reached.

Now, it is no uncommon thing for the four odd gentlemen to answer, as every one should do, by return post, and for the four odd ladies to withhold their reply for a week. What is the position of the hostess? She is reluctant to invite other gentlemen for fear the original quartette will arrive. If by chance they ultimately decline, the attendance is much curtailed, and she may not be able to get four equally suitable gentlemen, to say nothing of the fact that a delayed invitation is not regarded as complimentary. Many a hostess has been nearly distracted by tardiness of replies to her invitations.

A HOUSE PARTY.

What applies to the dinner party applies to a house party. Every lady in the country who entertains knows the worry and anxiety of arranging for a suitable little coterie of friends, one of whom may disappoint her at the last moment without any proper reason. Entertaining is often a source of real perplexity and discomfort.

THE DOCTOR.

Busy people cannot afford to be tardy in their ordinary business affairs. Take the case of the doctor. He tries with the most punctilious care to keep his appointments; he allots 20 minutes to an old patient or half an hour to a new one, with careful regularity, and if his waiting room becomes full, it is probably because some patient arrived late, or some ailment has taken an unusually long time to diagnose, and thus the whole machinery is put out of gear.

IN DAILY LIFE.

The sum of the whole matter is that punctuality is one of the virtues of life. It is a habit which all young men should form. In this busy age, when every avenue of professional and business life is crowded with eager aspirants, it will not do for any young man to overlook any of the factors conducing to success. Certainly the habit of punctuality is one of the important factors. The habit can be formed the same as any other. Begin at once to be punctual in all things.

MODERN METHODS OF COMMERCIAL EDUCATION

Commercial education is considered in these days to be a very important feature of the equipment of young men for business, and the development of the commercial training school has been very extensive. Not only have business colleges grown to a stage of high efficiency themselves, but as an outgrowth of them commercial courses have been introduced into the public and high schools, and some universities have established departments of commerce.

THE PUBLIC BUSINESS-SCHOOL.

The public business-school has become a very close competitor of the private institution of the same character, and as a consequence, the privately conducted institution has been forced to avail itself of the most improved and scientific methods in every particular.

THE TERM OF STUDY.

The modern business college of the most advanced type instructs its pupils in bookkeeping, shorthand, typewriting, business methods, commercial law, correspondence, and kindred subjects. The time required to complete the course is from four to eight months, varying with the adaptability of the student. One college announces that some of its particularly ambitious students have finished the complete course in from eight to ten weeks.

It will thus be observed that the student may advance as he chooses. There are no classes in which all do the same work. The system of instruction adjusts itself to the individual, and every attention is paid to the fact that the student is seeking at the earliest possible moment to devote himself to active business affairs. Each department of these schools is highly developed. In bookkeeping, for example, the fact is recognized that under the high-pressure methods of modern business, there is no time to train employes in business. The young man or woman who wishes to take a position must be ready to perform his or her duties at once. Consequently in the bookkeeping course, each rule and the reason for it are carefully explained to the student. He is given school currency, notes, drafts, invoices, etc., and works on living business transactions, instead of spending weeks in the dry study of mere text-books.

Every detail of a modern office is illustrated, and students are given actual practice in letter filing, letter-press copying, indexing and drawing up all kinds of business papers. The students are well grounded in arithmetic, and taught to be rapid and accurate in figure. They are also taught to write, not only speedily, but well. They take a course in common law, are drilled in letter-writing and spelling, obtain a complete understanding of the latest labor-saving methods of accounting, and are trained to perform all the details and routine of office work.

SHORTHAND.

In teaching shorthand the students are usually divided into three grades. When the principles of shorthand have been mastered, speed in writing is attained through systematic practice under the supervision of a skilled and experienced teacher. This point, in the best schools, is reached in from three to five weeks. The grades are then as follows: 1. Where dictation is at the rate of from 30 to 90 words a minute. 2. Where the rate is from 90 to 110 words a minute. 3. Where the rate is from 110 to 125 words a minute.

A MODEL OFFICE.

Some of the colleges have introduced what is called a "model office," where shorthand holds full sway. This office has every appliance and convenience of a modern commercial office. Here are duplicated the exact conditions that obtain in the offices of the largest and most progressive business houses.

AIDS TO PROGRESS IN STUDY.

Among the facilities for study are the newest style of desks, new typewriters, with the very latest improvements, the leading card-index systems, folio indices, letter presses, the mimeograph, the newest style—everything the student may be required to use later in actual business. All pupils regularly devote a considerable period of their time to this work, familiarizing themselves with the details of office routine, and obtaining a practical instead of a theoretical knowledge of business systems and methods.

THE SCHOOL CORRESPONDENCE.

The school correspondence, as well as that of the employment department, is conducted in this office. The instructor, who is here the employer, in effect, gives each student, in turn, actual dictation. This is then transcribed, passed to the instructor for examination, and, if necessary, is corrected. The student then attends to the copying, indexing, cross-indexing and mailing of the correspondence. It is a part of the plan of the more progressive schools to assist all their students to obtain positions, by means of a thoroughly systematized employment department, which keeps in close touch with a large number of business firms, from which requests for employes are continually received. Banks and trust companies have regularly on file with these institutions applications for the services of worthy young men and women and those competent are sure of a position.

FACTS ABOUT TRUSTS AND TRUST METHODS

Much condemnation has been heaped upon trusts, their methods, and the men that control them. A great deal of this adverse criticism has been of an unintelligent nature, and is the result of an inadequate knowledge of what trusts really are.

AN ILLEGAL TRUST.

That corporation, body of men or society that monopolizes an industry or controls the great part of it, and puts restraint on legitimate competition is illegal, and has come to be known as a trust. Against these soul and body crushing organizations, political parties have fought, legislatures have enacted laws, and competing business men have turned their heaviest argument and ammunition. It should go without saying that a monopoly is not necessarily detrimental to the best interests of the general public.

BIG CORPORATIONS MAY BE JUST.

It must be admitted that large corporations which have cheapened methods of production, and even control every channel of trade in their particular line, can be just to the consumer. As a matter of fact, such corporations generally abuse their privileges, and for that reason the public mind has come to consider every capitalist, every big corporation, as a blot on the economy of the universe. After having warned the reader to beware of prejudice against capital simply because it is capital, and is powerful, let us examine the workings of the so-called trusts—the evil monopolies.

SPECIAL PRIVILEGES GRANTED BY ENACTMENT.

Economists have said that monopolies could not live were they not granted special privileges, such as the right to lay gas or water pipes in a city's streets, to string wires, lay railway tracks, build pipe lines from state to state, and construct tunnels for pneumatic tubes, etc.

POWER OF THE MONOPOLY.

The power of the monopoly lies in the rights it possesses to the exclusion of competition. If only one gas company has the right to pipe a city, unless precaution of law is taken, it might be possible for that company to charge its patrons any price that would not be prohibitive of consumption.

To-day we see much of the supply of every-day necessaries controlled by trusts. The tendency of the age is towards consolidation in order to reduce expense of production. When there is only one company in a country using material for an article of manufacture which it controls, it may refuse to pay more than a price which suits its convenience, yet it can also refuse to sell its commodity unless it gets its own price.

FACTS ABOUT THE MODERN THEATER

Something of the glamour of romance and mystery veils the world behind the footlights to those who have never lived within that mystic circle, but the life is anything but romantic and mysterious to the players and the workers.

THE THEATER WORKHOUSE.

On the contrary, while to the public a theater is a playhouse, it is, to those connected with it, something of a workhouse. Either a mental or physical effort is required almost every minute of one's working hours. The ceaseless routine of duties necessary to the completion of each production commences at the desk of the manager, who reads the manuscripts of countless plays, and selects the one he thinks will most please the public.

THE MANAGER'S SELECTION OF A PLAY.

These manuscripts are obtained either from the playwright direct, or from the playwright's agent. Accompanying each manuscript is a statement of the royalty to be paid for the plays used. This right of royalty sometimes costs the manager as much as $1,000 a week. There are plays that cost even more than that; but the average cost is about $500 per week.

WHERE COSTUMES ARE MADE.

STAGE DIRECTOR'S PREPARATIONS.

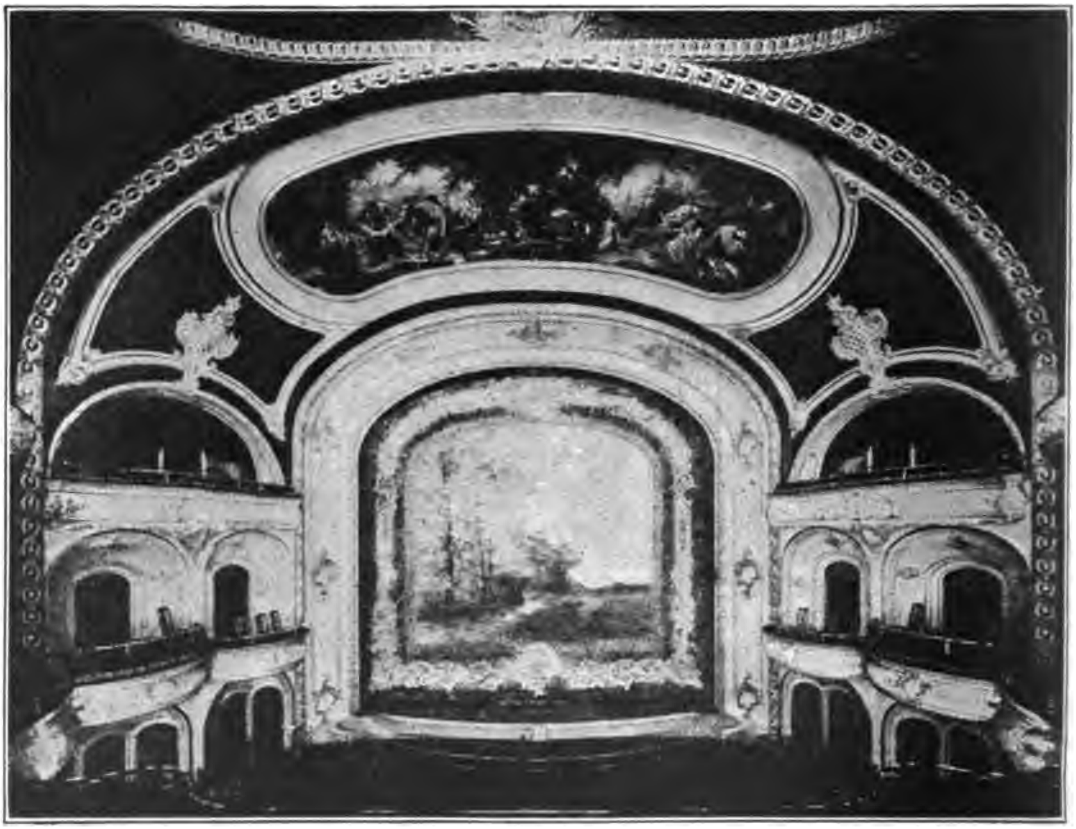
After the manager has selected a play to follow any given production, the manuscripts go immediately to the stage director.

who is the power behind the throne (footlights), and the autocrat of the world on and beneath the stage. It is his province to direct, and his duty to apportion, the various tasks involved in the mechanical construction and the mental preparation of a play.

After having read the manuscript the stage director begins "to plot," not like the villain in the play, but with pencil and paper. Using those business materials, he draws the scene plot, and several other minor plots, varying in number and importance according to the extent of the production.

THE SCENIC ARTIST, PROPERTY MAN, ELECTRICIAN AND STAGE CARPENTER.

This finished, he turns over the scene plot to the scene artist, who immediately wrinkles his brows for an imaginative conception of an original interior or a fresh landscape. The stage director assigns the property plot to the property man, who begins to get the hundred and one articles that are to be a part of the coming production. The light plot goes to the electrician, who at once begins planning the light effects for this particular play. Still another plot goes to the stage carpenter, who



VIEW SHOWING PROSCENIUM AND BOX ARRANGEMENT OF A MODERN THEATER.

at once sets about with saw, hammer and nails to make such frames as are necessary.

THE ORCHESTRA LEADER.

The "plotting" does not end here, for, the leader of the orchestra, whose duty it is to select the proper character of music for each situation — something tremulous, for the tears, something lively, for laughter, and something heroic for the melodramatic, is given a "plot."

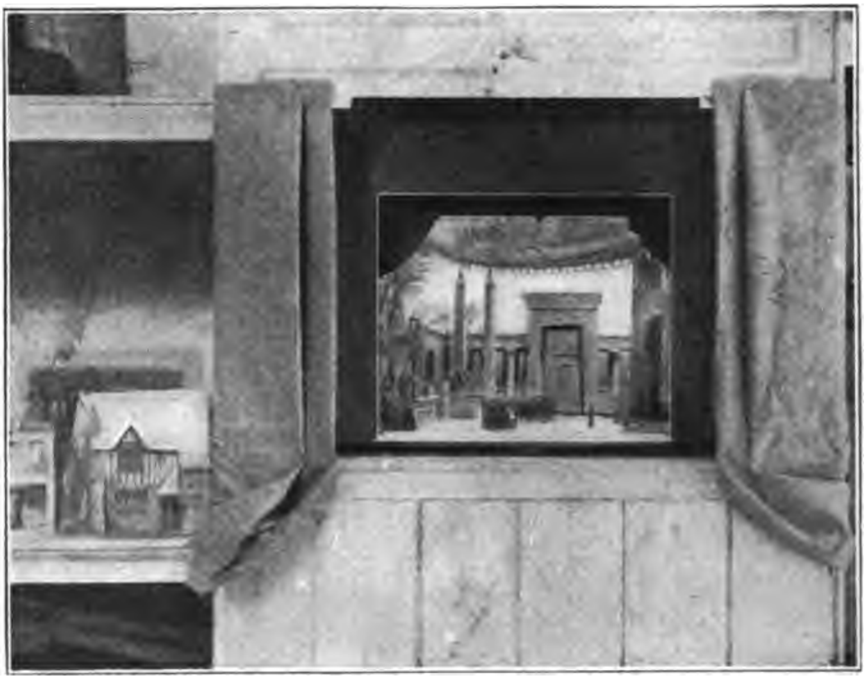
ASSIGNMENT OF PARTS.

These plots having been formed and distributed, the stage manager then proceeds to cast the play—that is he mentally canvasses the individual talents of the members of the company and assigns to each one the part most suited to that person. Sometimes a player possesses sufficient versatility to fill any role, but such versatility is rare. Good judgment in assigning the parts is therefore an indispensable attribute of a good stage manager. Not every player, to be sure, is invariably assigned to the part he would most like to play, but the part he would most like to play is not always the part he could play best. As to that, the stage director is the judge, and upon the correctness of his judgment frequently depends the success of the production.

WHERE SCENERY IS PAINTED.

UP IN THE "FLIES."

While the property man goes about the getting together of the "props" the scenic artists high up in the flies are busily working upon the scenery for the coming production. The paints are "cooked" and the colors blended upon such canvases as are to be used. For each production there is an entirely new outfit, giving a freshness of scenic investiture to each play that is practically impossible with traveling organizations.



MODEL FOR STAGE SCENE.

MODERN FEATURES IN STAGE PRODUCTION.

In producing plays at the present time nothing is impossible. Lightning is made to go zig-zag across the stage at the will of the electrician, miniature lakes and fountains are the work of the stage carpenter and manager, and, in fact, so far advanced are the methods of the modern stage that a locomotive may be made to appear as if going through flames at a terrific rate of speed, while in fact it is absolutely stationary. Flame is often made with cloth and colored lights. Steam is made to take the place of smoke. The ear, too, is deceived as well as the eye, and thus the most realistic effects are achieved.

All this varied and elaborate procedure involves a large expenditure, which finds its return, with a very handsome margin of profit, in the patronage received from the theater loving public. The popular tendency to crowd before the footlights never seems to diminish, and if the plays are of the proper character, the amusement and edification obtained from witnessing histrionic productions constitute a wholesome diversion.

FACTS ABOUT SPECULATION

Of all modern occupations, one of the most picturesque is that of the speculator who makes fortunes in the great stock and grain exchanges of the world, loses them on an unfortunate turn, and with great fortitude and energy wins them back again. To the public that learns of this man and his life work, he appears with a certain glamor, but in general, he is considered merely a gamester, who bets on the turn of a market.

HARD WORK ALONE BRINGS SUCCESS.

Men of such a grade, however, are hardly worthy the dignified name of speculators. True, the speculator has in him above everything the gambling instinct, but it is not by mere force of dollars and terrific gambling plunges, that the typical speculator wins immense fortunes. Here, as elsewhere, hard work only brings success. To the public it is only the spectacular side of the stock or grain market operator that appeals with force. But, lack of the whirr of the grain pit or the stock post, must lie indefatigable study and application, a resourcefulness almost matchless, and a knowledge not only of the men with and against whom one is trading, but of every fiber of the fabric of the commercial and financial world.

CONDITIONS COVERING SPECULATION.

To the speculator the insignificant happenings of a day may mean much. The values of speculative commodities may be affected by the slightest turn in public sentiment over a political situation. A war cloud, even though it be as small as a man's hand, may mean ruin or prosperity to him. These conditions all must be mastered both by a knowledge of them and their exact effect on lasting conditions, and by a knowledge of what opposing forces may develop from them.

THE GREATEST SPECULATOR IN WALL STREET.

Probably the greatest manipulator of stocks in celebrated Wall street was a gentleman who has been twice a multi-millionaire, and once a bankrupt for millions. Some men of the stock market desire to be identified closely with the companies whose stocks they manipulate, or buy and sell, up to hundreds of thousands of shares. Not so with this unique character. He is a manipulator pure and simple, one who by force of his large following of smaller speculators, and by his great foresight, can influence a market up or down by his plunges. To the layman, he simply bets on the rise or fall of the market quotations. To the initiated, however, it is upon faith in his knowledge of conditions that will influence the prices of stocks and bonds, that he makes his winnings. So far from being a stock gambler who bets on quotations, he can be called the one who makes quotations. Many times has he faced apparent defeat, and once he was ruined, as a result of trying to handle 1,000,000 bushels of wheat against his own judgment. At that time he showed the metal of which he was made. Falling from high life, he, a man used to luxury and the good things of the world, contented himself with a simple country house until by the same sagacity that made him rich once, he again became the envy of all speculators.

SPECULATORS WHO HAVE FALLEN.

There is another side of the speculator's life. While the fortunate ones are in the public eye and are heroes, there are others who have fallen in battle. It must be known, that while supply and demand and real intrinsic worth have much to do with the price at which the public buys and sells stocks, grains, cotton, etc., on the other hand, plunging, cornering a market and other kinds of manipulation, regardless of merit, may affect prices greatly. Thus we see times when one speculator, who is a "bull," has caught his arch-enemy "short," in such a manner that millions of dollars may be squeezed out of him. Men are prone to sell what they have not in their possession, trusting to conditions to depress prices and permit them to buy in at lower figures. But often this plan goes awry. The long line of "ghosts" of the stock brokers' offices. —men who have been buffeted in the fight. and who still haunt the scenes of their former victories, testifies to this.

SPECULATION SOMETIMES A DISEASE.

Speculation is in some people a disease in the blood that mounts to the head. Men may be cool and calculating in speculation; they may bravely withstand defeat and plan other great coups, but they cannot get away from the sound of the ticker, or the excitement of the market, after having won or lost a fortune.

TWO GREAT BUSINESS BODIES

Stocks and bonds, — money-exchanges, boards of trade—these terms convey little meaning to the many. The general opinion prevails that dealings in the stock and grain markets savor of nothing but gambling. To much of the trading in the great exchanges of the world this stigma must attach. On the other hand, these great exchanges fill a needed want in commercial and financial life, for which America has of late years become so justly famous. Let us look into the character of the men and operations of these great markets, which send out their influence to every portion of the world.

THE NEW YORK STOCK EXCHANGE.

Of greatest influence in the country, financially, from the point of view of the speculator, are the operations on the New York Stock Exchange. This famous bourse is located in the short but widely known New York thoroughfare—Wall street—and is an association, of limited membership, made up of men who gain a livelihood by buying and selling securities, such as stocks and bonds of the great railway and industrial corporations of the country. In the majority of cases, the sale of these securities is for third parties, who, recognizing that the stock exchange is the trading place where such investments can be made, commission these brokers to transact their business for them.

ORIGINALLY A CONVENIENT MARKET PLACE FOR SECURITIES.

From this statement it may readily be drawn that in the beginning the stock exchange served simply as a convenient market-place where the best bargains could be made in the matter of investment of idle earnings. Such was the case, and the prin-

INTERIOR OF A GREAT CITY BANK.

cipal earnings of the brokers who were members of the exchange were from the commissions made from the sale or purchases of securities.

STOCK GAMBLING—$80,000 FOR MEMBERSHIP.

This condition has changed materially. Probably the greater number of the members now make the most money in direct speculation on the rise or fall in the price of securities listed on the exchange. This gradually has led to the charge of stock gambling which is often justly made against that great medium of financial transaction. It is this speculative side of stock transactions which has at times involved thousands of persons in ruinous losses, and even the whole country in panics. At the same time these methods have become so generally interwoven with the ideas of the American people that, in order to secure memberships on the New York Exchange and to be able to enter into this speculative arena, men pay as much as $80,000, and more, for memberships.

A SPECIFIC CASE.

In order more clearly to explain the nature of transactions in stocks and bonds, a specific case may be cited. Let us say that "A" has idle money at hand which he desires to invest with a view to a good profit on his investment. He commissions a member of the exchange to buy for him a certain number of shares of a favorite stock or bond issue, at a stipulated price. The broker is paid his commission for transacting the necessary business and "A" becomes the owner of the shares. In case there is an advance in the value of the shares by reason of a betterment in the earnings of the corporation, thus bringing about increased interest or dividends to the owner, "A" may desire to sell his possessions. In that case, the broker may be instructed to sell the stock and A makes a good profit on his investment. If, however, the earnings are sufficient for "A," he may hold his stock indefinitely, for the dividends that accrue to him. This latter proposition is the more legitimate side of the investment.

To the speculator on the rise and fall in stock prices is due the business of buying on margins. This has entailed an operation called "selling short," which is truly nothing but stock gambling.

"MARGINS."

Operations on "margins" are the same as those cited in A's transactions save that instead of buying or selling the stocks or bonds outright, the business is done on a margin—that is the customer puts up about 10 per cent of the value of the stock traded in, and the broker lends the money at a fair rate of interest with which to complete the business. Thus "A" is able to buy heavily on a small capital. The trouble that often befalls a marginal trader is that in an erratic rise or fall of prices, the value of a stock may drop below or rise above the margin put up by the customer, in which event if more margins are not put up by him, the broker will close out the trade, and the customer loses the amount of the margin deposited.

"SELLING SHORT."

Short sales constitute selling stocks or bonds that one does not possess, trusting that conditions in the market will result in a depression of prices which will enable the seller to buy in the stock or bonds at a figure lower than the price at which they were sold short, thus giving the seller an ultimate profit. This sale is a contract to deliver to B by A a certain number of shares at a given price. Margins are also put up on short sales so that in case prices advance instead of decline the broker who sells for A and consequently has lent money with which to complete the transaction may be indemnified in a rising market.

"BULLS" AND "BEARS"—SLUMPS.

It might be well to define a number of phrases commonly used in financial circles, namely:

A "bull" is a person who favors an advancing market or price of securities; the term is supposedly derived from the action of a bull in tossing things upward.

A "bear" is one who favors lower prices; the term said to have resulted from the action of a bear in pressing its prey to the ground.

A "slump" is a marked depression in prices.

"PUTS."

A "put" is an option on stocks or grains which allows the seller of the "put" to deliver to the buyer certain stocks or grain at a price stipulated some time before the transaction. The price named is generally much in favor of the seller and the option enables him to "put" the commodity to the purchaser at a price generally higher than the market figures. This transaction is at the option of the seller.

"CALLS."

"Calls" are options just the opposite to "puts," enabling the buyer to demand the delivery of the commodity from the seller, generally at a lower price than the market figure. This transaction is at the option of the buyer.

THE "POOL."

A "pool" is an aggregation of speculators united to operate in certain stocks or commodities on exchanges. In railway circles a pool is a consolidation of interests by which certain earnings are made jointly by a number of roads and divided among the individual members of the pool at certain periods.

THE "CURB."

The "curb" is a market for commodities not listed on a regular exchange. This term derives its name largely from the fact that such trading was originally done on the street curb.

THE "ROOM TRADER."

The "room trader" is a member of the exchange who buys and sells for himself more than for outside customers.

A "CORNER."

A "corner" is a condition in the market when all the available supply of the article traded in, has been absorbed by a man or clique of men. This situation is generally brought on by very heavy short sales. The "shorts" can redeem their sales only from the crowd that has the "corner," who are invariably "bulls." The "bulls" then proceed to push the price up fabulously and the shorts must pay the difference between the price at which they sold and the price set at the will of the bulls. This condition often brings on a panic and sometimes results in the bankruptcy of the "shorts."

CANARDS.

It is no uncommon thing for the stock market to fluctuate violently on the merest rumor that tends toward financial depression. Because of this panicky feeling that often exists in the investing public, speculators often willfully set about to invent canards that will influence prices favorably to their operations.

OTHER STOCK EXCHANGES.

There are numerous other exchanges than that in Wall street, among which are those of Chicago and Philadelphia, the Mining Exchanges of Boston and Denver, and several other leading cities. In New Orleans, the Cotton Exchange is prominent for operations in the cotton market; the New York Cotton Exchange is also prominent in this trade.

THE CHICAGO BOARD OF TRADE.

Of as much influence, although of a different character, is that exerted by the Chicago Board of Trade, an exchange on which are regulated the prices of the grains and provisions of the world. This exchange is governed largely after the same manner as the New York Stock Exchange, excepting that the contracts made thereon are by members of the board for delivery of certain amounts of grains or provisions at certain specified times.

"FUTURES."

This business is called trading in "futures" or making contracts for future delivery.

At the outset it might be supposed that the future character of the transactions on the Chicago Board of Trade and the several boards of trades in the principal cities patterned after it, were purely of a gambling type. Such, however, is not necessarily the case.

CHICAGO A DICTATOR.

Chicago, from its location in the Middle West, the center of the great grain-bearing country, and admirably equipped with lake and rail connections for transportation, is in a position to dictate the movement of grain to a great extent. At Chicago, are also located the great stock yards and slaughtering houses from which the world receives its supply of meat provisions. Inasmuch as Chicago was a pioneer in the matter of grain handling the transactions on its board of trade gradually grew to proportions where they exerted an influence over the whole world. In this city are located the great elevators whence pours forth much of the supply of the world's breadstuffs.

Trading on the board of trade is done to a great extent in cash commodities, in which event the business is simply a purchase or sale similar to that over any counter. Purchases or sales for future delivery, however, are the life of the board, and constitute contracts for the delivery of grain before the last day of a specified month.

THE MONTHS USED FOR "OPTIONS."

The months of the greatest trading are those in which as a rule the grain of a harvest is most freely delivered, i. e., September and December for spring wheat, and May and July for winter wheat. Other months are traded in, but these show the largest transactions. Corn is dealt in most heavily in December, May and July. The contracts for these future deliveries are called "options." Sales for future delivery in almost every case are "short" sales. Occasionally, traders have the cash article in hand to deliver, and make sales for future delivery when prices are high. If prices fall off, the short accounts may be "covered" without regard to holdings in hand, or the holdings may be delivered on the contracts, which is the usual course of trading.

A TREMENDOUS VOLUME OF TRANSACTION.

Naturally there is tremendous business on the greatest of grain marts, purely from a speculative point. To the uninitiated, such business may appear to be of a gambling nature. There is, however, one important aspect in which it deserves much commendation. Through the methods of trading in futures,—trading that may be strictly legitimate,—the price of grains and provisions is regulated in such a manner that the grain grower and the provision dealer receive for their commodities a price far more equitable than could be obtained by scattered transactions through middlemen, ranging over the country. In the Chicago Board of Trade and other establishments that have sprung up after its model, center all news and information as to crops. Statistics in these exchanges show with great accuracy the probable supply and demand of the world. From these figures fair prices are set on the world's food supply. In case of great changes in supply and demand, or the conditions that regulate them, the quotations on the board of trade are first to feel the effects. Thus farmers may avail themselves of the best prices, and millers may readily contract for the wheat that they will turn into the next year's flour supply, knowing accurately the prices for sale and purchase.

COTTON COMPRESSED AND READY FOR SHIPMENT.

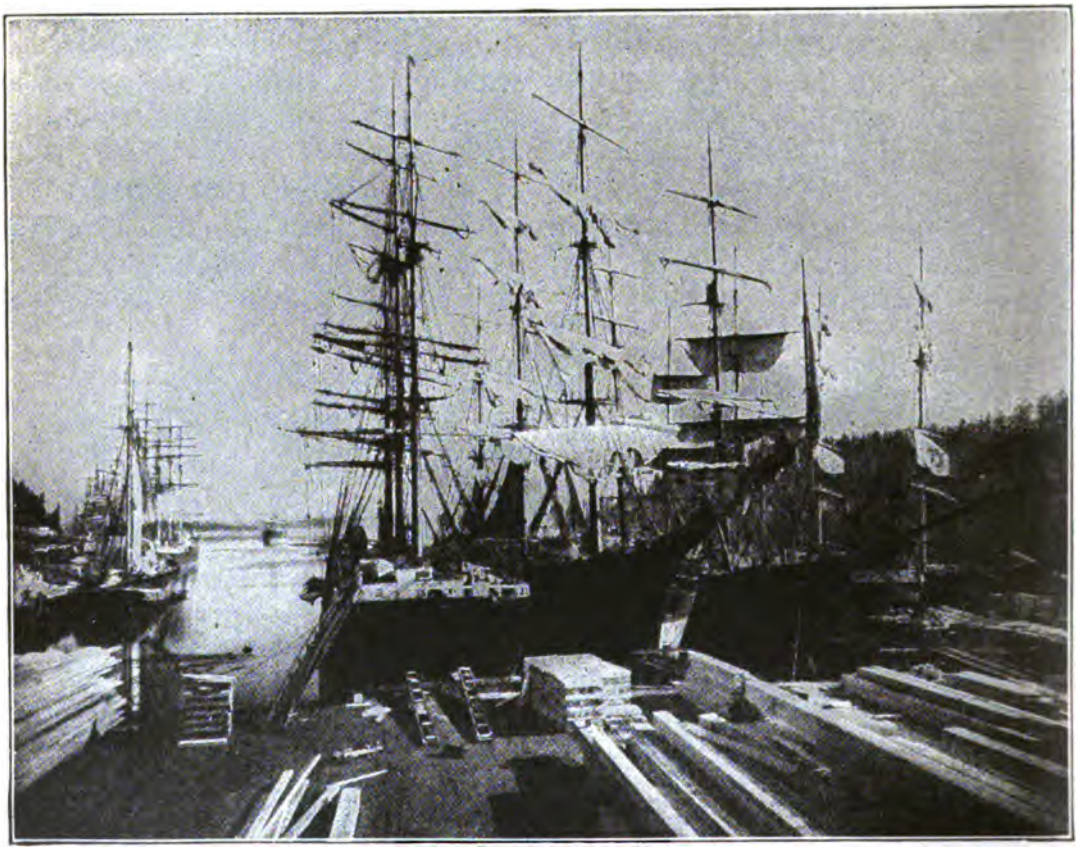
Notice the bales ready for shipment. Speculators keepaccurately informed as to all such shipments.

ODD MOTIONS AND SIGNALS.

In the grain trade as well as in the stock market, there are in constant use a great number of odd phrases and signals, which mean much in great transactions, yet which convey little meaning to the public at large. Millions of dollars worth of grain change hands on the motion of a finger. Deals are turned by the quick fling of an arm, and in general, so staunch to a bargain are the operators that many a transaction is carried through to the end without a written agreement of any kind.

SCENES IN THE "PIT."

The scene in the pits of the Chicago Board of Trade when this wild trading is in full swing, resembles a mob of men in a stampede, all with arms in air and with seemingly no way to take them down.



IN A PACIFIC HARBOR.
Merchant ships in the carrying trade with the Orient discharging cargoes and refitting at Bremerton. The economy of sail power, particularly on trading voyages, still keeps in commission many vessels of motley types, from the modest fore-and-aft schooner to the "clipper built" ships, which were once the pride of America, and controlled the tea trade of the world.

WORKERS UNDER WATER

For many purposes it is necessary for men to do work at the bottom of shallow bodies of water. It may be work in removing a wreck, in recovering treasure from a wrecked ship, or it may be necessary to construct work at the bottom of harbors, and various other purposes. The diving bell is not very much used, and yet for some kinds of work is the better means to employ and it has been brought to a high state of perfection.

The ordinary diving bell measures eight feet long, six feet wide and five and one-half feet high inside. It is a steel box open at the bottom, with heavy glass bull's-eye windows to admit light through the top. To it are fastened four chain slings with which the bell is lowered and raised. From the center at the top stretches the air hose and telephone and electric light wires extending to the air pumps above. Within the bell around the bottom are the blocks of cast-

THE MODERN DIVING BELL.

iron ballast, seats and footrails for the divers, and shelves and footrails for tools. A chain hoist hangs from the center of the ceiling, while the electric lights are attached in several convenient places. This outfit permits two or more men to work together, assisting each other, and with a freedom of motion which is impossible to the diver clad in armor, weighted down with diving weights, and with the resistance of water, and often tide, to contend with. The air supply required is large and air compressors worked by steam engines are necessary. As an additional precaution the pumps deliver their air into a large steel tank which contains a reserve supply lasting thirty minutes. The hoisting of the bell is done with a steam engine.

For the most part, however, submarine work is done by helmet divers in closed suits, and some of their most important and exciting experience in the recovery of vast treasures from sunken ships. The ship Hamilla Mitchell sank near Shanghai with specie to the value of $250,000. After long

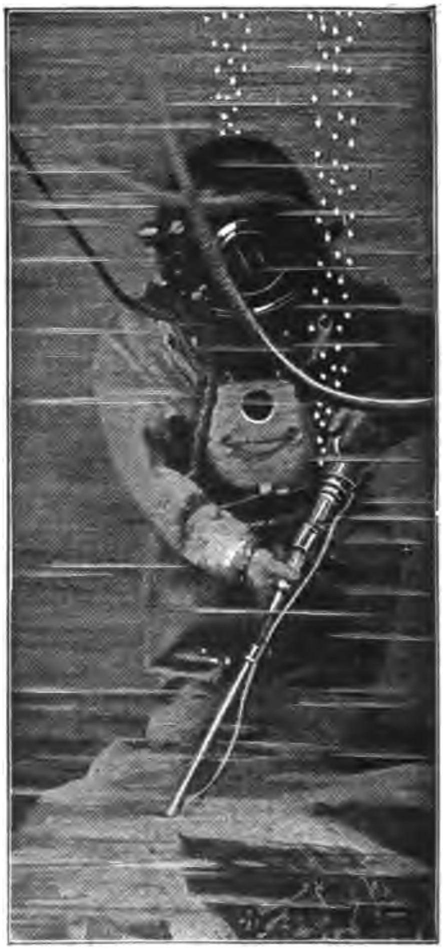
DIVERS DRESSED AND READY TO DESCEND.

searching on the floor of the ocean, the wreck was located in 160 feet of water. It had been submerged so long that worms had bored through some of the treasure boxes, dollars were lying around in heaps, and the diver worked four hours consecutively at that great depth, sending up sixty-four boxes of precious coin.

The recovery of boxes of gold coin worth $500,000 from the Spanish mail steamer Alphonso XII, off Point Gando, Grand Canary, was difficult because the treasure room was in the "run," or after-part of the ship, and below three decks. It took six months of the hardest kind of work to overcome all the difficulties of the situation. The depth was 160 feet, and the underwriters employed three specially selected divers for the task of locating and getting up the nine chests, each containing over $50,000 worth of gold.

These are but a few pages from the true story of these "toilers of the sea." It would be another long story merely to recount the ingenuity and capital which have been expended on the problem of locating and securing these prizes or to name the treasures which the dark, unfathomed caves of the ocean hold as yet out of reach of the searching hands of men.

For a great many purposes it is necessary to do considerable drilling on rocky ledges beneath the surface. At such times the divers carry with them a drill worked by compressed air. In the case of a famous wreck on La Touche Island, in Southeastern Alaska, the vessel was jammed in between two large hidden rocks and was held fast as if in the jaws of a gigantic vise, and all usual methods of recovery would have torn big holes in the hull, so another course was taken. First, a survey was made of the submerged rocks and a map prepared. It was then decided where to drill the holes for the blasts, and considerable time was occupied in this work, each hole plugged as soon as finished, to keep out the sand.



DIVER DRILLING.

So scientifically was the work planned and executed that when the explosion occurred the summits of the submarine mountains were torn away without injury to the ship.

FACTS ABOUT LAW

Law is a rule for action established by a government or other competent authority to regulate justice and direct duty. Law may be between God and man either in natural or revealed form; or it may be between man and man. The latter form is divided into several kinds: national or municipal, which may embrace constitutional, canon or ecclesiastical laws; equity or common law, which embraces what might be called public or criminal laws; and private or civil laws, besides which there is still international law.

CIVIL LAW.

Civil law is the system which the people of a State enact for their welfare. This branch deals particularly with all things not criminal. In that it is private, it has to do with actions between individuals, such as indebtedness, actions on notes, mortgages, etc., the adjustment or acquiring of titles, collections, marriage and divorce, and the like. Branches of the civil law are many, such as commercial law, which has to do principally with business affairs or commercial houses; insurance law, for regulating insurance companies; maritime law, for questions pertaining to affairs of the sea; military law, for armies; municipal law, for cities; sumptuary laws for people dealing in intoxicating liquors, etc.

CRIMINAL LAW.

Criminal law is generally punitive, where civil law exacts only a settlement. The state steps in to inflict a penalty on a malefactor who acts against the good of the public. Criminal carelessness is a crime, though accident is not. If a faulty boiler explodes, or a badly constructed building burns and causes loss of life, some one is liable to punishment for it. Yet a man may accidentally discharge a firearm and kill some one, and not be held for it.

Ignorance of the law is no excuse.

You may not lawfully condone an offense by receiving back stolen property.

POLICE ARRESTS.

Police are not authorized to make arrests without warrants duly sworn out before a magistrate, unless they personally know that an act has been committed that calls for the arrest.

FORCIBLE ENTRANCE ON WARRANT.

When a warrant has been sworn out for a man accused of crime, his house may be entered forcibly.

EMBEZZLEMENT.

Embezzling is theft by an officer, agent or servant of a corporation.

FELONY.

Felony is a high crime, the highest of the principal classes in which crimes are divided by statute. A grave crime exceeds in grade a misdemeanor.

GRAND AND PETIT LARCENY.

Grand larceny involves over $25, petit larceny anything below that amount.

ARSON.

Arson is the crime of feloniously setting fire to a building.

DRUNKENNESS NO EXCUSE FOR CRIME.

Drunkenness is no legal excuse for committing a crime, but when carried to the extent of delirium tremens, it may be adjudged insanity.

PERJURY.

Willful false swearing is perjury. A false statement under oath, which is qualified as the belief of the affiant, does not constitute perjury. Subornation of perjury is a felony.

FORGERY.

Forgery is the copying or signing the name of another with deceitful or fraudulent intention.

MURDER.

Murder in the first degree must have been premeditated, malicious and willful. Killing in duels is murder.

ASSISTANCE COMPULSORY ON POLICEMAN'S APPEAL.

Officers of the law are empowered to appeal· for assistance, and anyone to whom they may appeal is in law bound to assist.

INTERNATIONAL LAW

Between countries, as within them, there exists government which, while of the highest type, is yet of an anomalous order. International law is the code under which this government of the family of nations operates. Ages ago the dominating principle that existed among barbaric tribes was one of selfishness, the principal purpose of each petty king being to despoil his neighbor. Thus warfare was rampant.

CONFEDERATIONS, REPUBLICS AND EMPIRES.

When government was evolved with the growth of civilization more altruistic ideas began to prevail both among individuals and nations. Certain rulers saw that it was to their advantage to ally themselves with neighboring governments; peace was better than war. This led gradually to confederations, and later, to great republics and empires. We see in the coalition between the Grecian states against Xerxes' hordes of Persians this idea of common protection. Later, Rome gathered to itself the countries of the world. Then came the influence of Christian teaching to ameliorate barbaric conditions.

These drifts in governmental life indicated the eventual trend toward more perfect fraternity and altruism. In these crude agreements and treaties we see the tendency toward the more complex system of international law as we know it to-day.

By law one understands a rule or mandate enunciated by a power able to enforce its orders. In the strict sense of the word there can be no international "law," for, the enforcement of such laws presupposes a sovereignty above all governments subject to this law, to enforce it. Of course this does not exist, and in as much as every country is jealous in the extreme, of its rights of independence and sovereign power, submission to the law by offenders is the only method of enforcement save by war. Yet in this late day commerce, the interests of trade and the interchange of citizenship between different countries, have united the most enlightened nations into a family. In this imaginary family laws are self imposed, Governments, and through them their citizens, simply agree to preserve certain fundamental principles laid down and understood, as beneficial to all mankind.

All sorts of sources are tapped to make up this body of law. Common-custom agreements between nations such as treaties, protocols, etc., conventions between nations, called to frame rules for international government, resolutions by peace congresses, and the like, all give to this law certain authority. In custom we see embodied the ideas of equity. If armies and navies must go to war, let it be done in as humane a manner as possible. Custom also dictates a general Christian spirit. Where certain nations agree to do or not to do certain things by treaty, these agreements eventually have some force and influence in similar directions, with other nations. Where conventions of public spirited people or delegates from different nations meet, empowered to draft rules for general conduct, great weight is carried.

THE FLAG OF TRUCE—RED CROSS—TREATMENT OF PRISONERS.

Thus we see the flag of truce recognized generally between the armies of combating nations. Through this growth of a more kindly spirit we see better treatment of prisoners and the recognition of the Red Cross of the hospital corps. All nations likewise concur in numerous laws which are for the good of all. In this category falls the law that pirates are the foe of all mankind and shall be punished by death. No immunity is enjoyed by a pirate even if protected by a nation's flag.

Naturally agreements or treaties between nations are expected to be observed, else they would not have been made. These agreements upon proper authority, become an integral part of the law of the signatory nations. It is the duty of each nation which is a party to the treaty to obey it to the letter, to abrogate temporarily any of its laws which come in conflict with the compact, and to compel its citizens to uphold it. Thus two nations may make tariff agreements which bind them alone; or they may agree to deliver up certain malefactors, such as murderers and other criminals. In extreme cases of breach of treaty, war is the alternative to protect the injured country's rights.

Conventions occasionally are held by representative men of civilized nations, to discuss conditions of the nations of the world. Present at these conferences, if they are of importance, are men delegated by governments, many of them in power to draft laws favorable to their particular countries. Thus, certain rules have been laid down for all nations which are beneficial to each alike, as in time of war. These rules can be broken only on penalty of severe punishment of the one guilty of the violation. Some of the international laws that have been drafted and held obligatory on civilized nations include the recognition of the flag of truce and the hospital flag referred to. Others drafted have ruled that during war shipping of neutral countries shall not be molested; that privateering shall be abolished; that blockades, to be binding, must be in fact, and must be maintained by a force large enough to prevent access to the enemy's ports, and that murderous methods of warfare shall not be permitted.

TRIBUNALS FOR ENFORCEMENT OF TREATIES.

Naturally, tribunals must exist to enforce the rules of international conventions and treaties. Since international law enters into the body of the law of a land, its higher courts generally interpret it. Thus, in the United States the Supreme Court is the adjudicator of disputes over the law and in England the High Court of Admiralty generally acts.

In order to be properly represented in the various countries of the world each government appoints diplomatic and consular forces to be present all the time in the principal capitals and cities of the other nations. An ambassador or minister is an official appointed directly by the chief executive of a country to the court or head of the government of another nation. Generally these appointments are confirmed by legislative bodies. These men look after the interests of their sovereign or country, in the foreign state, the diplomatic agent taking care of governmental conditions, arranging treaties, etc., and the consular service taking note of commercial conditions and reporting them to the home country for the benefit of merchants and traders. The peculiar position of these officials abroad has laid down another law between nations that renders them and their families, houses, and public records inviolable in time of strife between countries. From this courtesy allowed by one sovereign power to another, there has grown up a fictitious notion that the sovereignty of a country follows its flag, and that, temporarily, the ship of a country floating its flag in a foreign port, or a diplomatic or consular residence, is actually the land of the country whose flag is flown. Such of course is not the case, but by agreement, ships and officials are given time to leave a country unmolested and in safety, even after war has been declared.

ARBITRATION, MEDIATION AND INTERVENTION.

Arbitration, mediation and intervention are the methods by which disputes between countries are often brought to an end. Countries are very jealous of their sovereign powers and seldom permit of interference of third parties in their troubles. Yet, sometimes, third parties step in to suggest a cessation of warfare when the struggle is carried to a great and cruel extreme. Nations have to resort sometimes to war to clear the atmosphere of disturbances. It is the only way where combatants will not arbitrate. Often, however, even after war, the warring nations will suggest committees to meet and arbitrate the questions at issue for them. This is generally done by each country appointing one party and these choosing a third, the decisions of the joint body being accepted. Some great disputes have been settled in this manner.

Sometimes a nation watches an unequal struggle between two powers, too long protracted. Then it may offer its good services between the struggling contestants in the hope of settling the disturbance. This is called mediation and, generally, is not unkindly received, even though it is refused. The third form of intervention is where a powerful nation simply steps in, takes matters in its own hands and enforces peace. This is intervention, such as the United States used in the war between Spain and Cuba. This method is seldom resorted to.

THE LEAGUE OF NATIONS.

The proposed League of Nations is an earnest endeavor of statesmen at the Peace Congress in Paris, at the close of the World War, to establish by international agreement what may be called a Supreme Court of the world to adjudicate cause of inter-nation disputes and thus eliminate wars. Experience only can decide whether such a league is practical. Its formation would reduce international law to a science. Perhaps the world is not yet ready for such a forward step, for all nations, members of such a league, would have to make concessions, this, nations conscious of their strength, dislike to do.

THE INTER-STATE COMMERCE LAW

Congress is empowered by the constitution to regulate commerce between the several states, and in 1887, under this authority, passed the inter-state commerce law which is in force now and which controls and regulates our internal commerce. This law has for its object the enforcement of equitable dealings on the part of all common carriers with the public, and applies to all such carriers, whether by rail or water, as convey goods or passengers from one state, territory or district of the United States into another. The sovereign power of the states which on this point was delegated to congress, was not surrendered as regards traffic within the state. Consequently the states also have commerce laws which govern traffic within their individual boundaries and have railroad commissions which act in a similar capacity to the inter-state commerce commission.

THE INTER-STATE COMMERCE COMMISSION.

This commission of the federal government is made up of five men empowered by the law to inquire into the methods by which carriers do business, and their rates of traffic charges. The law provides that all rates shall be just and reasonable and that there shall be no discrimination in favor of large shippers. Rates of traffic must be printed so that all shall be uniform under similar circumstances, on the same road. The books of the companies also must be opened at least once a year for inspection by the commission. Rebates to induce shipment by certain concerns are prohibited. Exceptions to the rules are made for carriage of property for the government, charitable institutions, and durin the time of fairs and expositions. Mileage at reduced rates may be issued in certains amounts, as well as excursion and commutation tickets. Reduced rates are allowed for clergymen and passes may be issued for officers of railroads. Passes, as such, however, are prohibited.

DISCRIMINATION IN RATES, REBATES AND POOLING.

And yet with law and commissioners to enforce the law, discrimination in traffic rates is frequent, and pooling, with unlawful rebating and other sharp practices, is common. The Sherman anti-trust act is violated continually. Railway managers have been brought to account repeatedly by the commission for disregarding published tariffs by according lower rates to larger shippers. Grain rates applied to export business have been manipulated to such an extent that for a long time they have been demoralized, and little export grain has moved by rail at tariff rates. The same is true in the matter of dressed meats shipped by the great Chicago packing industries. All sorts of methods are used to control business by the railroads, and in order to grant special and illegal rates to secure big customers, roads have been known to go as far as paying a so-called agent to secure

business for them, and the commission supposed to be paid this agent—sometimes amounting to 25 per cent of the freight charges—has been turned over at once by this agent to the shipper—an actual rebate.

LEGAL ACTIONS AGAINST RAILROADS.

While the inter-state commerce commission has been able to discover gross wrongs, such as the merging of competitive roads so as to control traffic, it has been unable to redress many of these wrongs, or to provide against their recurrence, because of the weakness and inadequacy of the law under which they operate. About the only thing that has been done is to ask the Attorney General of the United States to begin numerous actions in equity against railroads for violating the inter-state and anti-trust laws. These actions have fallen into three classes. One is that brought against the railroads in which preliminary injunctions were obtained which required them to apply tariff rates to traffic carried by them, and prohibited them from carrying on any inter-state traffic at any but the lawful published rates. Another case was the action against the great Chicago packers to prevent them from carrying on a beef trust or combination, which stopped all competition. Another was one against the Northern Securities Company and the several railroad companies which have been merged into it.

POLITICAL ECONOMY

Political economy is that branch of social science, or economy of the nation as a household, which treats of the production of wealth and its application to the well-being of society. The word "political" is not used in the ordinary sense, but simply as it applies to the body politic—the city or state. In other words, political economy is the systematic arrangement of the laws which, under the present system of competition, govern the relations of man, whether individual or social, to the objects of his desires.

FOUNDATION OF THE SCIENCE.

The science is based on four elemental principles: 1. The unlimited desire of man for the development of nature's resources. 2. The conveniences and comforts of civilized life, which are to be enjoyed only as the result of human labor. 3. The right of property in the fruits of labor, established by individual exertion with the idea of exclusive possession, as a natural consequence. 4. The natural possibility and right of exchange of the fruits of labor attending the right to property. All these things touch the sphere of man's social life with its manifold and complicated relations, from which proceed the most powerful incitements to stimulate desire, to nerve up labor, to maintain rights and to multiply and distribute the innumerable elements of wealth. The study of political economy delves into man's wants, nature's resources, the statistics of human invention and industry, and the principles which should obtain in social relations. Self-interest is regarded as the universal motive of human action, and in this study of prime interest, are the mutual relations and intercourse of men as governed by that motive. It takes it for granted that labor is irksome in most cases, and that every man is striving to obtain the utmost possible gratification with the least possible effort.

WEALTH.

Since wealth, the fruit of labor and desire, is the principal thing about which this science treats, a clear idea of what wealth is should be obtained at the outset. The term wealth embraces all useful things which can be appropriated and exchanged. This naturally combines utility, or fitness to gratify desire, and fitness to be seized and held in exclusive possession. It is an error to identify wealth with money. Money measures things, and to a certain extent is a medium of exchange for all things, but it makes up only a small part of wealth. It is desirable not for what it is, but for what it can purchase. It is also an error to regard as wealth such things as mortgages, bonds, stocks and the like. These are simply indications of wealth which exists in another form. These are signs, not substance. It is also an error to exclude from the list of the things that make up wealth, a song, speech, or other things that are not tangible or durable.

VALUE AND PRICE.

In distinction from wealth, we have a term "value," which is only a vague way of expressing the desirability of an object. Value is purchasing power, or that quality which gives an object power to command other objects in exchange. Price is a term distinct from value, in that it has reference to a single article,—money. To illustrate the difference between the terms value and price, it may be said there can be no general rise or fall of all values, but there may be a general rise or fall of prices, from the inflation of currency, or some similar cause that affects money, which is the only object by which all things are compared. Value also is distinct from utility, for anything that gratifies a desire is of value, but some things of the highest utility, such as air, light, or water have no exchangeable value. Thus it may be said that value has two elements, viz.: utility and cost, or the difficulty of obtainment measured by the amount of labor necessary to secure the object.

PRODUCTION AND DISTRIBUTION.

From this point the study of political economy branches in several directions. Production and its methods and means, such as natural resources, labor, and capital, should be considered. The distribution of wealth such as property, wages, profits and rent, also come in for study, Then there follow the study of the exchange of wealth, of the laws which govern value, the rise and fall in prices, the stability of currency or money, the supply and demand which regulate prices, and other similar conditions. There is also the influence of society at large, and of government, upon wealth, its method of production, etc.

PROTECTION AND THE "BALANCE OF TRADE."

From the study of this science it has been thought at times that a nation could be regulated the same as a household, by adjusting the getting and spending of the national wealth. Thus have arisen doctrines, now in the main discarded by economists, such as that of "the balance of trade," which teaches that trade with any nation is profitable only when more can be sold to that nation than is bought from it. The system of bounties upon special trades arose, and similarly, has grown up to the great system of protection to native industry, which has marked the revenue policy of the United

States for many years past. Following the laws and theories on this question, have arisen numerous schools of economists, who believe that their particular tenets constitute the cure for all ills. Among these schools are the socialists, the communists, the single-tax followers, and even the anarchists, who believe in no government.

In the space permitted here, it is not possible to treat of the details of the numerous laws which make up this science. Those subjects most important for consideration are the actual methods that have been put into use by governments, or have been made the rallying cry of some political party.

FREE TRADE.

Free trade is a term expressing a principle which has been used to a great extent as a party platform for the Democratic party in the United States. Trade consists in buying and selling.

There is free trade when there is no interference with the natural course of buying and selling, if such interference be intended to improve or otherwise to influence trade. It is necessary to keep this distinction in view, because there are many laws not contrary to the spirit of free trade, which interfere with buying and selling. For instance, it is unlawful to deal in slaves, because we do not acknowledge the right of one human being to be the owner of another; it is unlawful to sell intoxicating spirits without having obtained a license, because the tax for the license brings revenue to the treasury, and intoxicating spirits are a commodity which it is advisable to tax in preference to the common necessaries of life, or even harmless luxuries. Many of the last named cannot be brought into this country without paying customs duty. In some countries, however, this tax is for revenue merely, and is a restraint on trade.

IMPORTS AND EXPORTS.

The many attempts made by governments to regulate trade for the purpose of benefiting the communities over which they rule, may be divided into two great classes: the one prohibiting the exportation of commodities, and the other encouraging exportation and prohibiting or discouraging importations. The former was the old rule in many countries. It was supposed that the wealth of the country depended on retaining within its limits certain productions of native growth or industry, and their removal out of the country was prohibited or restrained. Until a late period, the exportation of machinery was prohibited in some countries, but this was an exceptional remnant of the old rule which had yielded to its converse, in which it was maintained that exportation is the source of wealth, and importation is a wasting of the nation's wealth.

NATIONS LIKE INDIVIDUALS, IN TRADE.

Nations are like individuals, making in trade, profit on what they buy and sell. Whatever communities import they pay for by exports. This can be shown by analysis in any class of national transactions. If we pay for the goods we import by bills of exchange, these bills represent goods exported, otherwise they would not be paid. If we pay for goods in money, it is the same thing. It is a sort of a dynamic law that exportation causes importation just as a vacuum is filled up by air.

As applied to the individual, and not to the nation, free trade is the right of every man to do as he pleases with his capital and abilities; and as the general desire of man is to improve his condition, and in fact, the great majority are thoroughly devoted to this purpose, the interests of the nation at large cannot be in better hands than in those of men, who, in increasing their own wealth, are increasing the wealth of the public. Free trade expresses the principle that a nation's wealth and prosperity are best promoted by securing the utmost freedom for the exchange of all commodities among its own people, and with the people of other countries. In contradistinction with free trade, protection expresses the principle that in order to promote home industry, the importation of certain articles from countries where they can be produced cheaper than at home, should be prohibited, or restricted by heavy duties.

OPPOSING THEORIES.

It is generally admitted by both parties that, theoretically, the presumption is in favor of free trade. For all economic processes and results in their general aspect, the law of free trade is most favorable. The right of property implies freedom for every one to do what he will with his own, providing he does not infringe upon the rights of others. Any law restricting the free exchange of one form of property for any other, or its free transfer from one place to another, is a violation of a natural, universal, inherent right. The social instincts of men prompt them to the practical adoption of this principle of freedom of exchange. Free commercial intercourse between the nations of the earth tends evidently to establish their mutual relations upon a basis of peace and good will. But by the mutual exchange of values, different peoples become acquainted and assimilated with each other, and a feeling of interdependence creates a common interest, out of which grow the ties of abiding friendship. The nations of men are of one blood and constitute one family; and all the face of the earth, with its great diversity of resources and productions, is given to the one human race. In view of these things, we are justified in saying that the presumption is strongly in favor of free trade. On the advocates of protection, is thrown the burden of proof of the soundness of the principle of restriction. Let us look at some of the arguments, pro and con.

It is said protection is necessary to secure that variety of industry and that balance of different industries which are essential to a people's prosperity. Every country has a great variety of resources, and the developmen of all its resources conduces to its greatest wealth. Among the population of every country there is a corresponding diversity of native talent, and labor is most effective when every one has scope for doing that for which he is best fitted. The actual wants of men are equally diverse, and the highest happiness of a community depends upon the degree in which all are provided for.

A DIVERSITY OF OCCUPATIONS.

A diversity of occupations makes a home market for all sorts of products, saving cost of transportation, favoring division of labor, and binding all classes together by ties of mutual helpfulness and common interests. Varied industry favors the social and moral advancement of a people, quickening and broadening minds, enlarging hearts, and impelling to noblest action in the lines of rectitude and benevolence.

The advocates of the protective system strongly affirm that it is necessary to secure diversified industry. Foreign competition crushes out the home production of all but the crudest and coarsest articles of manufacture, and prevents the establishment of varied industry, unless the government interferes to restore the equilibrium by discouraging imports. Superior natural resources or more abundant capital, or cheaper labor, or greater skill and better improved machinery, may enable manufacturers in another country to produce certain articles more cheaply than they can be produced at home. If the way is open, the country having these advantages can, at first, control the marketing of these articles in a country less favored in this respect. Having once gained that control, it will do all in its power to keep it.

INTRODUCTION OF A NEW INDUSTRY.

The introduction of a new manufacture is a matter of costly experiment, and individuals should not be expected to bear the whole burden of carrying it on at their own loss, or great risk, until they are strong enough to compete with those who have had a long training and successful experience. It is contemplated that this burden will be but temporary, and will be more than compensated for by the greater ultimate benefits of a diversified industry fully established. Protection is needed to nurse our manufactures in their infancy, and to hasten their development.

Foreign competition bears directly and hardly on the wages of labor. The general rate of wages in our country is higher than elsewhere. Protection is also said to be a necessary means of maintaining national independence. It is of the highest importance that a nation in the time of war should be independent of foreign countries, with respect to supplies for subsistence, etc. The advantage of a home market for agricultural products presents a strong reason in favor of protection, because many products are perishable. It is also regarded, as before stated, as favoring the fullest and best application of the principle of the division of labor.

Protection is often advocated and used as a means of retaliation for commercial disabilities imposed by other nations. A foreign government bars out our products and, in turn, we refuse to receive theirs.

Aside from these causes for the protection policy, of which the Republican party in successive administrations of the United States government has been the best exponent, political policy may be pointed out as one favorable argument. The business community in this country has adjusted itself to the protective tariff, and anything that threatens to disturb the present system causes alarm in manufacturing and other business centers, whether warranted or not.

PROSPERITY.

Gradually, a good many people have come to believe that inasmuch as great prosperity has followed the protective policy, it will continue so to do. Moreover, the revenues of the country have been so large from customs duties that the country has greatly increased its national wealth, and on a similar scale the protection of certain industries has been so marked that, becoming monopolies, almost, of the entire trade in their particular branches, they have dominated the world, and largely increased the influence of the United States.

On the other hand, we have a goodly array of argument against protection. Foremost, because what is known as the "Iowa idea," formulated by a section of the party that has fostered protection, is that heavy tariffs, such as have been enforced for this purpose, in reality foster trusts and monopolies, by driving out foreign competition. This strikes at the root of protection. Akin to this idea is that of reciprocity, or trading with a friendly country on a free basis, but by treaty. Anti-protectionists argue that if it is good to exchange with certain friendly countries on a treaty basis, the same idea carried still further would be productive of further good.

Protection introduces and fosters antagonism between the different industries of the country. The idea of giving protection to every branch of industry is absurd. The theory implies special encouragement to the production of certain articles. But when government interferes to favor one industry by raising the price of all its products, it taxes all other interests. The unnatural stimulus given by protective legislation to a single industry leads to over production and consequent stagnation and failure. Protection diminishes the legitimate revenues of the government, at the same time that it lays a heavy tax on the people. A government must be sustained by revenues derived from taxation. The imposition of equitable duties on imports is admitted by the advocates of free trade as a legitimate mode of raising a revenue. A strictly revenue tariff has no discouraging influence on trade, nor does it conflict with the free development of a nation's varied industries. But a protective tariff has another end in view. That end would be most fully obtained by duties high enough to prevent altogether the importation of certain articles.

DUTIES FOR REVENUE ONLY.

The policy of protection in its application must be unstable, disturbing the course of industry by frequent changes. Protection tends to demoralize national legislation. The so-called lobby influence at Washington has become proverbial. Protection tends also to corrupt the public morals and the public service. It offers a strong temptation to the violation of the law, by smuggling.

THE PROPER CIRCULATING MEDIUM.

In the study of political economy, much attention has been given to the subject of money and currency. The country has seen great waves of change in ideas as to the proper circulating medium. Careful study will convince any one that, as we have said, the value of money lies not so much in its intrinsic merit or value, as in its utility as a measurer for exchange, and to some extent as a medium by which exchange is made. Gold has been in constant use by most countries of importance, because, seemingly, its fluctuation in actual value as compared to the value of the things exchangeable for it, is less than that of any other precious metal. For an ideal measure of exchange several qualities are necessary. It should always bear the same relative value to other things —those things whose value is to be measured by it; it should be in sufficiently large supply to serve as a medium, and of convenient size and weight. These determine its serviceability, both as a measure and as a medium of exchange.

In the original state of trade, everyone simply bartered one thing against another. To-day, when most business is done on credit, we must have a third thing by which to measure one thing against the other. This, if it is acceptable to everyone, and has the qualities noted, will be good money. Naturally, supply and demand cause fluctuation in money as in other commodities. If the currency of a country is suddenly inflated by heavy issues, it cannot be quickly absorbed, and falls off in its purchasing power. This was the harm done by the excessive issues of greenback money, and it was this inflation, instability of value and medium power, that people objected to in the free coinage of silver. It was known that the price of silver fluctuated violently at times, and consequently it would not serve as a stable measure of exchange, for future contracts. The most ideal measure would be a composite of all values of all commodities, compared with each other, to serve as a unit. That is by comparing cloth, potatoes, gold, silver, coal, eggs, butter, etc., a unit could be arrived at which would never relatively change. This, however, is considered impracticable.

INTRINSIC VALUE—CREDIT.

Intrinsic value is a good thing in money, for then it is not necessary to vouch that the measure of exchange when presented in exchange is of good value. As a matter of fact, governments, and private firms, to a great extent, simply use the dollar in the United States as a convenient way of measuring the exchange of goods, and often do millions of dollars worth of business with the actual exchange of only a few dollars. This is credit. The government does likewise in monetary matters. Great issues of money are put out for the use of those who need a medium of exchange, but much of this is simply printed paper—in other words we do business on the credit of the government, which assures the final payment for the paper in actual value. Faith in the government sustains this credit.

PANICS.

One of the most dramatic events in the history of any nation is a panic. This is purely a phase of political economics. It has to do with the expansion of credits to such an extent that business is no longer safe, and fear, coming over the people who have granted credit, brings down ruin on financial and commercial undertakings. A panic is the direct result of over speculation. When times are good and everyone has plenty of wealth, and more than he needs, he seeks to find some way of investing it. He lends his wealth, gives credit, and enters enterprises of dubious character without hesitation. With so much money on hand, prices advance, people feel in good spirits and everything is boomed. Then the trend in this direction reaches its limit. Men who have borrowed against the future find that they have invested poorly, and have no means with which to reimburse their creditors. Creditors become frightened at the risk; everyone calls for a return of loans, and no one cares to give credit except at a greatly advanced interest. Inasmuch as the greater part of the business of the country is done on credit, this sudden contraction brings on a desire on the part of everybody to secure value or cash money for what they have in hand that is of value. No one, therefore, wants to buy; all desire to sell. Prices fall terribly. People who owe debts, when they have realized only a small sum for what they thought was very valuable, see that they cannot meet their obligations, because their wealth has diminished in price measure. Bankruptcies follow, and sometimes the disaster spreads ruin over many.

FACTS ABOUT CIVIL SERVICE

One hears a great deal about the civil service in these days, and of the laws that are being enacted to regulate it. This service comprises the departments of work under the various municipalities, counties, states and under the federal government. Men and women who work for a public body are said to be in the civil service. It is a well-known fact that politicians in general seek for patronage, or the power of appointing men to office, else they would not strive so hard to be elected, or pay such large sums in aid of certain political parties in campaign times. It can be readily seen that civil affairs in most departments can be conducted much more efficiently if employes who give satisfaction, and who have spent a long time in becoming acquainted with their work, are kept in office regardless of politics, instead of having all public business turned upside down at every election. The effort that has brought about this feeling and put it into practice is called civil service reform, and the laws enacted to carry it out are styled the civil service laws.

The persons employed in the various civic offices of the country number hundreds of thousands. Under the United States government there is the postal service, with its thousands of clerks and carriers, the treasury department, customhouse officials and employes, consular agents, pension clerks and many others. Civil offices in all the states hire great numbers of clerks and laborers, and the counties and cities and towns need policemen, and firemen, and clerks. In President Jackson's time, "to the victors belonged the spoils," and there was a general discharge of employes with every political change of administration. At such a time, the efficiency of the public departments fell to a very low degree. Many times money was paid by subordinates to get their appointments, and much corruption followed. This was true up to a late date in the city of New York, under the control of Tammany Hall.

LEGISLATION TO CORRECT ABUSES.

Abuses went so far in the civil service of the country at large that in 1883 Congress passed laws limiting the appointing and removing power of elected officials. Many departments have since been brought under these laws, and further enactments have been made to hedge about the service. These laws provide for competitive examinations for applicants for positions, and for the promotion of employes through merit rather than influence. But influence still plays a large part. Frequently, trusted officials meet with rebuke for disobeying the law in this respect, and there is opportunity for great improvement along the line of clean service under the merit system.

QUALIFICATION FOR ELIGIBILITY.

Notwithstanding the abuses which work against the law and service the movement for a merit system all over the country has had a salutary effect. The examinations are competitive, the highest on the list receiving the appointment. Persons addicted to the habitual use of intoxicating liquors will not be accepted. Applicants must also be in good health, and must give proof of good moral character. In many cases recommendations from well known officials are necessary. The examinations are not difficult, save in technical departments, where expert services are required.

The following are some of the subjects on which applicants are examined: penmanship, orthography, arithmetic, interest, discount, the fundamental rules of bookkeeping, the elements of geography, history of the government of the United States, the English language, letter writing, and the proper construction of sentences.

THE ILLINOIS CIVIL SERVICE LAW.

To illustrate the system of civil service, the following extracts from the Illinois civil service law, which governs most of the departments of the civil service of Chicago, are given:

No person shall be admitted to examination for any position in the official service who is not a citizen of the United States, and who has not been an actual resident of the city of Chicago for at least one year next preceding the date of the examination.

Unless otherwise provided in these rules, no person shall be admitted to examination for a position in the official service who is less than twenty years of age at the date of examination, except that applicants for positions of pages and messengers must not be less than 17 years of age at the date of examination.

In special examinations for any place requiring technical, professional or scientific knowledge, or manual skill of a high order, the commission may wave the requirement of residence in the city of Chicago, fixed in Section 1 of this rule.

Application for admission for examination shall be made on blanks in such form and manner, and supported by such certificates of persons acquainted with the applicant, as the commission may prescribe. These blanks will be furnished to applicants for examination.

No question in any examination shall relate to political or religious opinions or affiliations, and no appointment or selection for an office, or employment within the scope of these rules, shall be in any manner affected or influenced by such opinions or affiliations.

EXAMINATIONS.

Examinations shall be held at such times and places as the commission shall designate, and two weeks' notice thereof shall be given, as provided by law.

The subjects for the examination shall be designated from time to time by the commission and shall be such as the needs of the service require, and such as tend to prove the qualifications of the applicant for the office sought, and may include special tests of fitness for any particular place requiring technical, professional or scientific knowledge, or manual skill.

Proficiency in any subject shall be credited in grading the standing of the person examined in proportion to the value of a knowledge of such subject in the branch or part of the service which the applicant seeks to enter, and also the applicant's physical qualifications and health. The relative weight of each subject shall be fixed by the commission for every examination.

The name of no person shall be entered on a register of eligibles whose standing, upon a just grading in the examinations, shall average less than 70 per centum of complete proficiency in the subjects of the examination, taken as a whole, and of such minimum mark as may be fixed by the commission for any part thereof.

All questions used in any examination shall be first approved by the commission. All examinations shall be conducted under the supervision of, and examination papers shall be marked under the regulation of, the commission. The same series of examination papers shall not be used a second time. No examination papers and no examinations shall be subject to review by the Civil Service Commission, or any of its members, after the posting of the eligible list.

All competitors who attain a general average of 70 per centum or over (and of such minimum mark as may be fixed by the commission for any part thereof) shall be eligible for appointment to the place for which they are examined, and their names shall be enrolled in the order of general average upon the proper registers, which shall be in such form as the commission shall prescribe, and shall be called the "Register of Eligibles."

Names shall remain upon the registers of eligibles for two years from the date of their enrollment unless sooner removed under authority contained in these rules, or by appointment. At the expiration of one year, the eligibles shall, upon a form prescribed by the commission, furnish new certificates of character.

PROMOTIONS AND REMOVALS.

All promotions in the classified service, unless herein otherwise provided, shall be from grade to grade, and shall be made upon voluntary, open, competitive examination. Competition in such examinations shall be limited to the employes in the next lower grade of the same position, serving in the department in which the position exists, unless the Commission shall deem it for the interest of the service to admit competitive employes in other grades or other divisions, serving in that or other departments.

No officer or employe in the classified service who shall have been appointed under these rules, and after examination shall be removed or discharged except for cause, upon written charges and after an opportunity to be heard in his own defense. When a removal is deemed necessary, the appointing officer shall immediately notify the Commission in writing of the grounds therefor. Such grounds shall be investigated by the Commission, and the accused person shall be given an opportunity to be heard in his own defense, provided, however, that such officer or employe shall file a written request for investigation within three days after the date of his removal. The finding and decision of the Commission shall be certified to the appointing officer and shall be forthwith enforced by said officer. Pending such investigation, the appointing officer may suspend the accused for a reasonable period, not exceeding 30 days. Nothing in this section shall be construed to require such charges or investigation in cases of laborers or persons who have the custody of public money, for the safe keeping of which another person has given bonds.

THE GLOBE'S GREATEST RIVERS

THE AMAZON.

A score of navigable rivers empty their volume into the Amazon, and many smaller streams are its tributaries. Its course is mainly through Brazilian territory. Its sources are the Tunguralnia, flowing from the Peruvian Lake Laurichocha, and the Ucayalo, which originates in the Apurimac, 600 miles long, issuing from the Peruvian Andes. From the junction of the last-named stream, the Amazon runs nearly 1,800 miles to the Atlantic Ocean. Its actual length is 4,000 miles, and its estuary, gradually broadening as it approaches the sea, attains at the mouth a width of 180 miles. The basin of the Amazon includes about 2,000,000 square miles of soil.

THE MISSISSIPPI.

The Mississippi ranks next to the Amazon among the world's great streams. Rising in Lake Itasca, Minnesota, it runs southeasterly, with an extent, including its tributaries, of 4,400 miles. Together with these tributaries, the current of the Mississippi drains an area of about 1,100,000 square miles. It takes in the volume of the Missouri river near St. Louis, and meets the waters of the Ohio, where the states of Illinois, Kentucky and Ohio come into contact. Confluent with the Mississippi at their respective points of junction are the Illinois, Iowa, Wisconsin, White, Des Moines and St. Francis rivers. It is also joined by the Arkansas river south of its junction with the Ohio, and by the Red river as it approaches its outlet, in Louisiana.

The delta of the Mississippi, 120 miles south of the city of New Orleans, is composed mainly of three "passes," which afford entrance for ships of large tonnage from the Gulf of Mexico. These are called the Northeast Pass, the Southwest Pass and the Main Pass. Steamers of moderate draught ply the Mississippi for 2,000 miles above the delta.

THE YUKON.

The Yukon river has its source in British Columbia, and its outlet in Behring Sea. Its drainage basin includes a surface, approximately, of 200,000 square miles. The Yukon was formerly notable for fine fish, which it still produces, but its attractiveness in this regard was entirely overshadowed, in 1896, when the famous gold discoveries were made in a creek flowing into the great river. The width of the Yukon 600 miles from the ocean is about a mile. It is navigable for nearly its entire length of 2,000 miles.

THE NILE.

The river Nile is variously estimated at from 4,100 to 4,500 miles long. By most geographers its source has been supposed to be in Victoria Nyanza Lake. At Khartoum, the former capital of the Egyptian Sudan, its two arms, the Blue Nile, issuing from Abyssinia, and the White Nile, flowing from the southwestern part of the continent, combine into a single stream, and constitute the main Nile, which courses its majestic way to the Mediterranean. Its delta is 120 miles wide between its west mouth at Rosetta and its east mouth at Damietta. The Rosetta mouth is 1,800 feet wide. The Nile is at flood from June to September, after which it subsides until January. Its mean rise at Cairo is 40 feet.

A DAY WITH THE STOKER ON SHIP-BOARD

The man who feeds the furnace of the marine boiler is summoned to his task at eight bells.

A SLAVE OF THE TOWERING BOILERS.

Hurriedly donning his working outfit, he descends many rungs of iron ladders until he reaches an iron platform on the bottom of the hold, where for four hours he must strive as the slave of the two or three towering boilers in front of him. Above him, through a circular opening, comes a current of fresh air, sent down by the big ventilator on deck.

FEEDING THE ROARING FURNACE.

With feet stretched wide apart on the sloppy platform, he seizes a shovel and throws wide open the doors of the roaring furnaces in turn, the vessel sometimes pitching violently. With tense muscles and a desperate sort of energy, he shovels in coal in great quantities, and occasionally rakes the surface of his fires. At intervals he pokes them with "slice" and "devil" to prevent clogging of the bars, until the furnaces are in a fierce, white glow.

CLEANING THE FIRES.

When the stoker finds it necessary to "clean the fires," he throws open the door of one furnace, while the others, at their utmost blast, are supplying the needed motive power. Laboriously working his "slice" and "devil" into the innermost vitals of the raging mass, he pulls out a quantity of clinkers, blistering hot. This he at once dampens, causing a choking smoke. After repeating the process several times, until the furnace bars are clear of obstruction and the upward draught is perfect, he replenishes the somewhat enfeebled fire with more fuel, and applies himself to the other furnaces likewise.

All this requires incessant and intense exertion in the face of roasting heat, and involves an exhaustive strain upon the stoker. Instances have occurred in tropical climates where he was totally unable, when relieved, to climb on deck, but fell on the reeking floor, limp as a heap of wet rags.

A DOUBLE RELIEF AND EXTRA RATION.

On account of the severe requirements of his task the stoker has eight hours off, instead of the four hours which compose the sailor's relief period. It is not uncomcon, also, for him to be favored with a better ration than the sailors get, in the shape of a mess from the galley called the "black pot," composed of remnants from the saloon passengers' fare.

THE COAL BUNKERS AND THE "TRIMMER."

The coal supply of the ship is stored in high bunkers, with water-tight doors opening into the stokehole. Out of these magazines the trimmer, also under a fearful strain, throws the coal to a point convenient for the stoker. Although not exposed to fiery heat, he has no cooling air-current from overhead, but must work in a close place, and with the aid of a safety lamp.

COAL USED ON A SINGLE PASSAGE.

Some ships use 3,000 tons of coal in a single passage, consuming from 20 to 30 tons per hour.

A DAY ON AN OCEAN LINER WITH THE STEWARD

The steward of an ocean liner has a big job on his hands when he provisions the great ship for its round trip between the United States and Europe. This journey generally takes about twelve days, and with its great cargo of human freight, the vessel is nothing short of a floating city. The amount of edibles and drinkables, to say nothing of other provisions for the passengers' comfort, gives the steward food for thought.

A CREW OF 450 AND A PASSENGER LIST OF 2,000.

In the first place, the ship carries about 2,000 passengers, to say nothing of its big crew, 450 in number.

ASSISTANTS NUMBER 150.

To give an idea of the amount of work upon the steward's shoulders, it may be stated that he requires 150 assistants. He must care for the needs of the passengers, and one of the principal needs is the passengers' stomach supply.

TRIP REQUIRES 200 BARRELS OF FLOUR.

The amount of bread consumed on board, which the steward has to provide, is in itself startling. Over 200 barrels of flour are stored away to help supply the bread and pastry. Next to bread, of course, comes meat. In the old days the steward must needs carry his livestock along and kill it on board. This, however, is all done away with now, for, with the modern improvements have come excellent refrigerating plants, and each ship is equipped with a big one, where tons of meats can be stored away conveniently.

PASSENGERS EAT 54,000 POUNDS OF FRESH MEAT.

Into these compartments, the day before the ship sails away, the steward must pack 20,000 pounds of beef, 14,000 pounds of lamb, 10,000 pounds of mutton, 500 pounds of veal and 500 pounds of pork.

FIVE THOUSAND PIECES OF GAME NEEDED.

Game also is in demand, especially among the first-cabin passengers, and Mr. Steward must see that all his people's wants are gratified. Therefore he packs away a stock that exceeds by far the supply of the greatest hotels in the country. Here also he stores over 5,000 pieces of game, including 500 spring chickens, 500 capons, 200 roasting chickens, 300 fowls, 500 ducklings, 50 goslings, 120 turkeys, 200 pheasants, 300 partridges, 800 squabs and 600 quails.

FRESH FISH, 3,000 POUNDS—SALT FISH, 2,500 POUNDS.

Altogether, the steward must pack away in the refrigerators about 3,000 pounds of fresh fish and 2,500 pounds of salt fish. About 30 barrels of herring, something like 15,000 in number, are also put away in the refrigerators. Besides these come 50 boxes of smoked fish, 500 pounds of lobsters, 400 tins of sardines, 500 pounds of turtles, 20,000 oysters and 10,000 clams.

TRIP REQUIRES TOTAL ANNUAL EGG PRODUCT OF 277 HENS.

Nor does this suffice. Eggs must be had in great numbers. The total annual product of 277 hens is consumed each trip

Nearly a ton and a half of oatmeal must be provided, most of which goes to the steerage passengers.

TWO TONS OF HAM—5,000 POUNDS OF BUTTER.

About two tons of ham and bacon are used. Butter, jams, jellies and marmalades are shipped in enormous quantities. About 5,000 pounds of butter are used, and as much of jams and such sweets.

SUGAR, 10,000 POUNDS—TEA, ONE TON—A TON AND A HALF OF COFFEE.

Of sugar, 10,000 pounds are packed away. Almost a ton of tea and about a ton and a half of coffee are taken on board by the steward and his assistants.

POTATOES NEEDED, 46 TONS.

Enormous tanks of milk are filled and carried over to supply the passengers. Vegetables in great amount add to the stores. Of this latter commodity, 46 tons of potatoes are shipped.

DISHES ALMOST INNUMERABLE.

Besides taking care of all this produce, the steward must see to the china and the utensils used to cook and serve the food in. There are 250 coffee pots and tea pots, 200 sugar bowls, 250 vegetable dishes, 100 butter dishes, besides 10,000 pieces of china for first and second cabin use, and 3,600 plates and 1,500 cups for third-class passengers.

YEAR'S CONSUMPTION OF FOOD ABOARD.

In the course of a year, the steward makes about ten round trips, and in that time he has ordered and served 540,000 pounds of meat, 50,700 head of poultry and game, 200,000 oysters, 25,000 eggs, 15,000 pounds of tea, 25,000 pounds of coffee, 50,000 pounds of butter, 200,000 oranges, and 2,000 barrels of flour.

OLD CLOCKS AND WATCHES

In his "Hyperion," Longfellow tells us that in the belfry of the Kauthaus in Coblenz is a huge head, with a brazen helmet and a beard, and whenever the clock strikes, at each stroke of the hammer this giant's head opens its great jaws and smites its teeth together as if it would say: "Time was—Time is—Time is past!"

THE "MAN IN THE CUSTOM HOUSE."

This figure is known in all the country round as the "Man in the Custom House," and when a friend from the country meets a friend from Coblenz, instead of saying: "How are all the good people in Coblenz?" he says, "How is the man in the Custom House?"

A REMARKABLE CLOCK IN PRAGUE.

Another very remarkable clock is found at Prague, near the old Hussite church. The clock itself forms part of the original tower, while the face or dial is exposed to the street. This dial is six or eight feet in diameter, and has a great number of hands, recording hours, minutes, days, months, years, and even centuries. The dial is set in an elaborate framework, about eight feet high and fifteen feet long, and this metal framework is ornamented with many curious and quaint devices. One of these is connected with the striking of the hour. Such clocks are curious but not useful.

AN OLD JAPANESE TIMEKEEPER.

In Japan is an old timekeeper of remarkable construction. This clock, in a frame three feet high and five feet long, represented a noon landscape of great loveliness. In the fore ground were plum and cherry trees and rich plants in full bloom; in the rear was a hill, gradual in ascent, from which flowed a cascade, elaborately imitated in crystal. From this point a thread-like stream glided along, encircling in its windings, rocks and tiny islands, but presently losing itself in a far-off stretch of woodland. In the sky turned a golden sun, indicating, as it passed, the striking hours, which were all marked upon the frame below, where a slowly creeping tortoise served as a hand. A bird of exquisite plumage, resting on a plum tree branch, by its wings proclaimed the expiration of each hour. When the song ceased, a mouse sprang from the grotto near-by, and, running over the hill, disappeared.

THE CLOCK AT GENEVA THAT EXCELLED ALL OTHERS.

Droz, a mechanic of Geneva, produced a clock which excelled all others in its marvelous construction. On it were seated a negro, a shepherd and a dog. When the clock struck, the shepherd played six tunes on his flute, and the dog approached and fawned upon him. The King of Spain came to see this wonderful invention, and was delighted beyond measure. "The gentleness of my dog," said Droz, "is his least merit; if your majesty touch one of those apples which you see in the shepherd's basket, you will admire the animal's fidelity." The king took an apple, upon which the dog flew at his hand, barking so loudly and so naturally that another dog which had come into the room, began to bark also.

TERRIFIED COURTIERS.

The courtiers became terrified, deeming it witchcraft, and crossing themselves, hastily departed. Droz requested the only one who ventured to remain, to ask the negro what time it was. He did so in Spanish, receiving no reply. Droz remarked that the negro had not learned Spanish, whereupon the question was repeated in French, and the negro immediately replied. This frightened the questioner also, and he, too, beat a hasty retreat, sure that the whole thing must be of the devil.

THE WATER CLOCK.

The first clock of which we have any account was invented in Alexandria, Egypt, about 245 B. C. One hundred years later the water clock, a very rude and imperfect timepiece, was introduced into Rome. The water issued drop by drop through a hole of the vessel and fell into another, in which a light body that floated marked the height of the water as it rose, and by these means indicated the time that had elapsed. At first the water flowed out rapidly, so that the clock required much regulation.

WEIGHTS AND WHEELS.

With slight variations in form of construction, the water clock served the purposes of mankind for more than a thousand years, and not until the eleventh century did clocks moved by weights and wheels appear in Europe, at first in the monasteries. Some of them were very costly.

THE SALADIN OF EGYPT TO THE EMPEROR, FREDERIC.

In 1232, the Saladin of Egypt sent to the Emperor, Frederic, a clock worth 5,000 ducats. It resembled a celestial globe, in which figures of the sun, moon and other skill were impelled by weights and wheels, performing their courses in certain fixed intervals.

In about 200 years the common people began to want to know the "time o' day," and clocks were placed in the towers of public buildings. Among these were many wonderful examples of mechanical skill and ingenuity, that at Strassburg being especially noteworthy.

THE STRASSBURG AND PADUA CLOCKS.

Strassburg had its first public clock in the year 1370; Padua, some time in the 14th century; Courtray and Dijon, in 1382. There was little improvement in clocks until the middle of the 17th century.

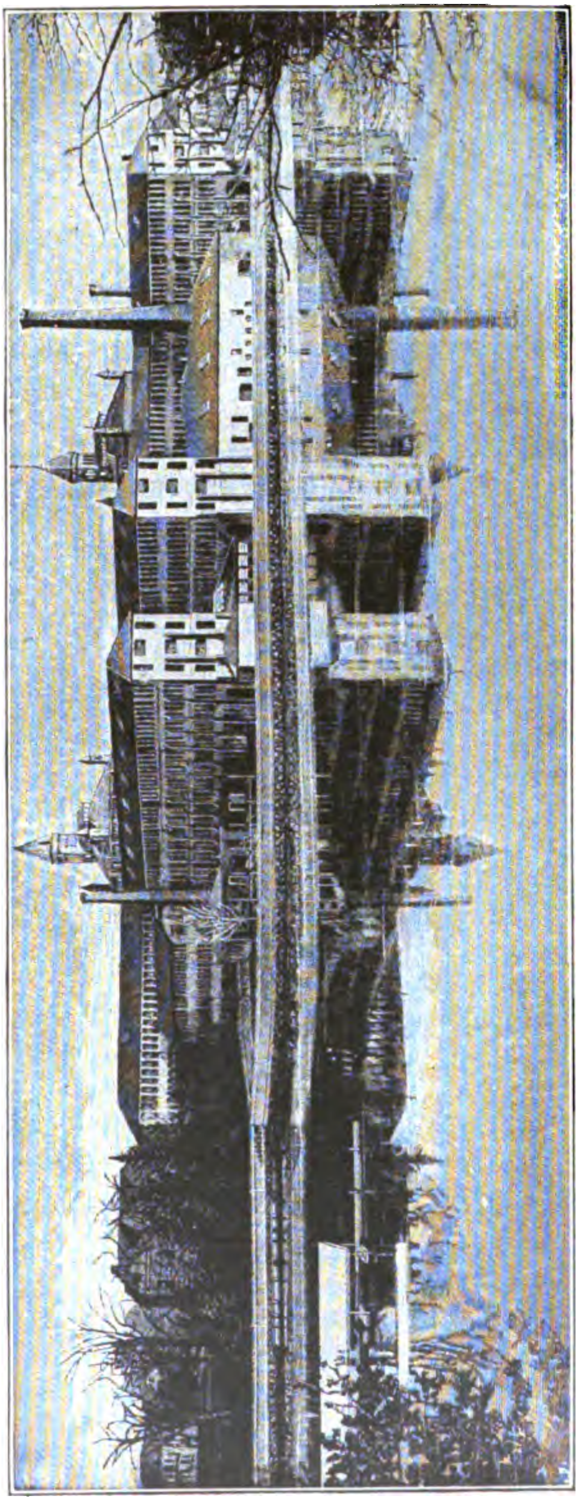
ELI TERRY'S WOODEN CLOCK.

Eli Terry of Plymouth, Massachusetts, made the first wooden clock in 1793.

WATCHES.

The watch dates from about the middle of the 16th century, the first being very cumbrous. The opposite extreme in size was reached 150 years later.

In 1764, John Arnold completed and presented to George III a watch three-fifths of an inch in diameter, perfect in all its parts, and repeating the hours, quarters and half quarters. Its size was that of a silver two-pence, and its weight, that of a sixpence.



Courtesy of American Waltham Watch Co.

REAR VIEW AMERICAN WALTHAM WATCH CO., WALTHAM, MASS.
Organized 1852. The company has manufactured and delivered since then 12,000,000 watches.

THE RELIGIONS OF THE WORLD

Learned men estimate that there are at least 1,000 forms of religious worship practiced in the world to-day. These may be classed under four great heads, viz.: the Pagan, the Mohamedan, the Jewish and the Christian. Of these, the chief Pagan religions now existing are: Fetichism, Brahmanism and Buddhism, Confucianism, Taoism and the primitive religion of the North American Indians.

The number of followers of Christianity is estimated at 506,000,000, with 800,000,000 followers of the other creeds. Thus it is that Christianity claims nearly two-thirds as many as the other sects combined.

CURIOSITIES OF THE BIBLE

The Bible bears no date. It comprises 66 documents, or books, and is supposed to have been written by 40 men. The Book of Isaiah has 66 chapters. There are 54 miracles recorded in the Old Testament, and 51 in the New Testament.

SHORTEST AND LONGEST VERSES.

The shortest verse in the Bible is John xi: 35, "Jesus Wept." In point of words, but not of letters, another verse is equally short, viz.: Thessalonians, v: 16, "Rejoice Evermore." The longest verse is the ninth verse of the eighth chapter of Esther. Esther is the only book in which the Deity is not mentioned.

NUMBER OF CHAPTERS, WORDS AND LETTERS.

The Bible contains 3,566,480 letters, 773,746 words, 31,173 verses, and 1,189 chapters. The word, "Lord," occurs 1,855 times, and the word, "and," 46,277 times. The word, "Reverend," occurs but once, and then in the ninth verse of the 111th Psalm. The middle verse in the Scriptures is the eighth verse of the 118th Psalm. The 21st verse of the seventh chapter of Ezra contains all the letters of the alphabet, with the exception of the letter "J." In the Bible, are no words or names with more than six syllables.

THE BEGINNING OF CERTAIN THINGS

Envelopes were first used in 1839.

Anæsthesia was discovered in 1844.

The First Steel Pen was made in 1830.

The First Air Pump was made in 1654.

The First Lucifer Match was made in 1829.

The First Balloon Ascension was made in 1783.

The First Iron Steamship was built in 1830.

Ships were first "copper bottomed" in 1783.

Coaches were first used in England in 1569.

The First Horse-Railroad was built in 1826-7.

The Entire Hebrew Bible was printed in 1488.

Gold was first discovered in California in 1848.

The First Steamer plied the Hudson in 1807.

The First Watches were made at Nuremburg in 1477.

Kerosene was first used for lighting purposes in 1826.

The First Newspaper Advertisement appeared in 1652.

The First Copper Cent was coined in New Haven in 1687.

The First Telescope is said to have been used in England in 1608.

The First Sawmaker's Anvil was brought to America in 1819.

The First Locomotive used in America was placed in service in 1829.

The First Almanac was printed by George Van Purbach in 1460.

The First Chimney was introduced into Rome from Padua in 1329.

Glass Windows were first introduced into England in the eighth century.

The First Steam Engine was brought to America from England in 1753.

The First Complete Sewing Machine was patented by Elias Howe, Jr., in 1846.

The First Society to promote Christian knowledge was organized in 1698.

The First Manufacture of Pins in America was soon after the War of 1812.

Glass Beads were found on mummies over 3,000 years old.

Gas was first used to illuminate in 1702, and first used in New York in 1827.

The First Glass Factory in the United States was built in 1780.

The First National Bank in the United States was incorporated December 31, 1781.

The First Temperance Society in the United States was organized in Saratoga, New York, in 1808.

The First Machine for Carding, roving and spinning cotton in the United States, was manufactured in 1786.

The First Society for the Circulation of the Bible was organized in 1805.

The First Telegraph Instrument was operated by S. F. B. Morse in 1835.

The First Union Flag, with 13 red and white stripes and the English cross in one corner, was unfurled over the camp at Cambridge, Massachusetts, January 1, 1776.

The First Daily Newspaper appeared in 1702.

The First Newspaper in the United States was published in Boston, September 25, 1790.

The First Religious Newspaper, the "Boston Record," was published in 1815.

The "Shoe Black" first came into vogue in 1750.

THE TAHITIAN'S FIRST GLIMPSE OF NAILS.

When Captain Cook first visited Tahiti, the natives were using nails made of wood, bone, shell and stone. When they saw iron nails, they fancied them to be shoots of some very hard wood, and being desirous of securing such a valuable commodity, they planted them in their gardens.

WHERE THE VARIOUS AMERICAN INDUSTRIES ARE MAINLY CARRIED ON

The United States Census Bureau has issued a report indicating the places where many of the most important of American industries are concentrated. Measured by the value of products, these points are as follows:

COLLARS AND CUFFS.

More than 85 per cent of the collars and cuffs are made in Troy, New York.

OYSTER-CANNING.

More than 64 per cent of the canning of oysters is done in Baltimore.

GLOVES.

More than 54 per cent of the manufacture of gloves is carried on in the adjoining cities of Gloversville and Johnstown, New York.

COKE.

More than 48 per cent of the coke supply comes from the Connellsville district in Pennsylvania.

BRASSWARE.

More than 47 per cent of the brassware in the United States is made in Waterbury, Connecticut.

CARPETS.

More than 45 per cent of the manufacture of carpets is carried on in Philadelphia.

JEWELRY.

More than 45 per cent of the manufacture of jewelry is carried on in Providence, Rhode Island, and the adjoining towns of Attleboro and North Attleboro, Massachusetts.

SILVERWARE.

More than 36 per cent of the silverware manufacture is done in Providence, Rhode Island.

MEAT INDUSTRY.

More than 35 per cent of the slaughtering and packing business is done in Chicago.

PLATED AND BRITANNIA WARE

More than 32 per cent of the plated and Britannia ware is made at Meriden, Connecticut.

AGRICULTURAL IMPLEMENTS.

More than 24 per cent of the agricultural implements are made in Chicago.

SILK.

The whole of the silk manufacture in the United States is conducted in Paterson and West Hoboken, New Jersey.

PACKING HOUSE EMPLOYES IN SOUTH OMAHA.

The number of wage earners engaged in slaughtering and meat packing in South Omaha, Nebraska, constitutes 90 per cent of the total number employed in all industries in that city.

IRON AND STEEL.

The iron and steel industry forms 89 per cent of all the industries in McKeesport, Pennsylvania.

POTTERY.

The pottery manufacture constitutes 87 per cent of all business in East Liverpool, Ohio.

QUESTIONS ON STRIKING FACTS.

Referring to Great Nations, give some ems showing the greatness of our country.

What is money?

Is money essential to civilization? Why?

Why is the production of gold important?

From what ore is most of aluminum pro-ired?

How many forms of water are there?

How does the water you use compare with hat of some great rivers?

How does electricity affect milk?

What is a bird reservation?

What event did the last International Exposition commemorate?

Were there ever any wild camels in the United States?

What is the principal college game?

What the principal professional game?

What is the principal game for general exercise?

What are some of the dangers in mountain climbing?

How much fresh air is required for health?

How can you test air for impurities?

How can you improve your spare moments?

Where is the native home of the ostrich?

Why do they raise them in California?

Describe your favorite form of athletic sport.

Describe your form of athletic exercise.

What is the necessity for ventilation? For baths?

How can you help yourself mentally?

Read suggestions about success—what ones seem to you most important?

We mention a number of success factors. Which is the most important, and your reason?

On a former page we described the cannon ball submarine for diving purposes. How does it compare with present methods?

What is the difference between the theater as we have described it, and the moving picture show?

What is a speculator?

What is "selling short"?

What are margins?

What is a "corner"?

What is the difference between civil and criminal law?

What is International Law?

What is a flag of truce?

What is political economy?

What is wealth?

What is the difference between protection and free trade?

What are imports? What are exports?

What is civil service? How is it applied?

What is the largest river in the world?

How does it compare with the Mississippi?

Where is the largest bell in the world?

Where is the largest cave?

Where is the highest volcano?

We have described Kilauea. How does it compare with Popocatepetl?

We mine far more gold than formerly, the world's trade is immensely greater. Any relation between these facts? Why?

What part of the total agricultural productions of our country is the gold mined?

Will a thunder storm sour milk? Why?

Where is the largest bird reservation?

Mention important international expositions.

What can you say of the importance of music?

What are the principal points about letter writing?

Why is punctuality important?

Mention methods of obtaining a business education?

What is shorthand?

What is a trust?

What is a monopoly?

Mention some important trusts in this country.

What is the danger in trust methods?

Describe the ordinary diving bell.

Mention some instances of valuables recovered by divers?

Describe some of the methods of staging a play in a theater.

What is essential to successful speculation?

What is a stock exchange?

Mention some points of interest about the New York stock exchange.

In speculation, what is meant by "The Curb"?

What makes Chicago a dictator in the grain market?

What means have speculators of determining the prices of grain?

What is law?

Name some crimes?

What is the foundation of international law?

What international law did Germany violate in the invasion of Belgium?

What are the duties of ambassadors?

What are the duties of consuls?

Mention some important disputes with England settled by arbitration.

On what is it based?

What is the difference between value and price?

What is the "balance of trade"?

Give arguments for and against free trade. Also protection.

What is meant by "duties for revenue only"?

What has been the prevailing practice in the United States?

What are the essentials of a circulating medium?

What is the only real money in the United States?

What is a panic?

Mention some panics in the United States?

What government official in your town is protected by civil service?

Describe the great river of Alaska. Of Egypt?

Mention some supplies that must be carried on an ocean steamer.

Describe the wonderful clock in Venice. In Geneva.

What was the water clock?

When was the first Union flag made?

When was kerosene first used for lighting purposes?

When was the first newspaper published in America?

Where is the most jewelry made?

Where the most silverware?

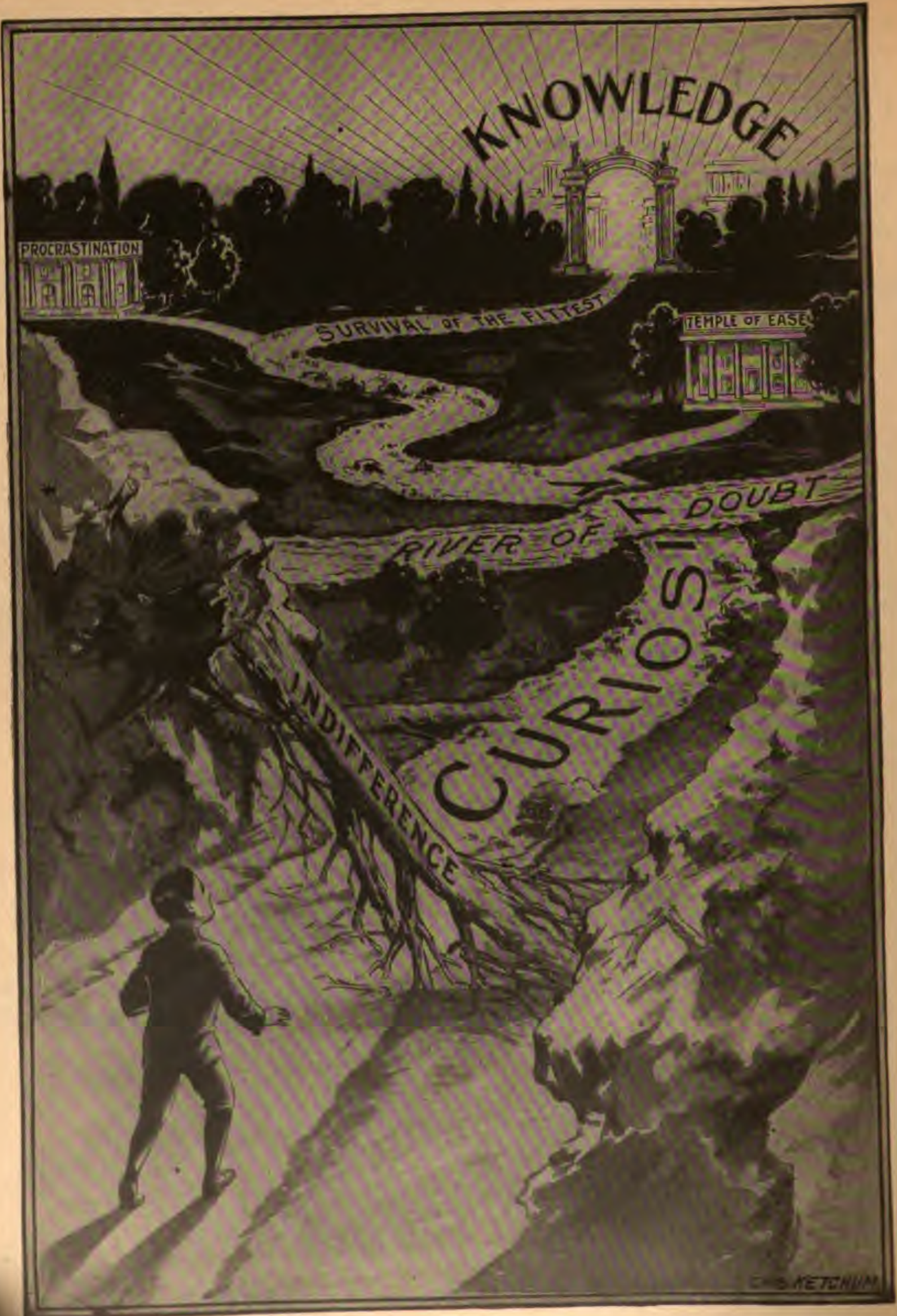
Where the most silk?

Where is the center of iron and steel industry?

BOOK VI

THE WONDER DEPARTMENT

Curious but Interesting Questions Answered for the Benefit of Children and Young People. Questions whose Consideration Around the Home Fireside Arouses Curiosity, Awakens Interest and Develops Mental Strength


KNOWLEDGE
PROCRASTINATION
SURVIVAL OF THE FITTEST
TEMPLE OF EASE
RIVER OF DOUBT
CURIOSITY
INDIFFERENCE
KETCHUM

THE WONDER DEPARTMENT

INTERESTING QUESTIONS FOR ALL AGES, ASKED AND ANSWERED IN THE HOME CIRCLE

This section could be classed as the Curiosity Department of the KNOWLEDGE LIBRARY. It is designed primarily for the young and to help parents and teachers to answer natural questions of childhood; which is as essential for the mental development of children as nourishing food is essential for physical growth.

To test the understanding questions extending the principles involved in the answers given are in many cases added. Children should be encouraged to frame other questions of similar import as well as to answer the numerous thought-questions included in the answers here given.

A pebble near the source of a river may change the direction of its flow. Interest aroused in childhood days, amid the pleasant surroundings of the home circle by thoughtful consideration of such questions as these may change the trend of an entire life.

WHERE DO THE DAYS BEGIN?

Of course, you know we have different kinds of time in this country. When it is noon at Chicago, it is one o'clock in the afternoon at Washington, but eleven o'clock in the forenoon at Denver.

Now, suppose you went to bed in Chicago at nine o'clock Sunday night. If you could jump to San Francisco in an instant, you would find it was only seven o'clock Sunday evening. Then if, the next minute, you could jump two thousand miles further west to the Sandwich Islands, you find it only half-past four Sunday afternoon. If your next jump in less than a minute's time could be to Manila, in the Philippine Islands, you would find it eleven o'clock in the forenoon, but the people would be calling it Monday

Somewhere, then, between the Sandwich Islands and Manila, the people stopped calling it Sunday and commenced to call it Monday. Our travelers and scholars, and learned men generally, have agreed, for the sake of convenience, to take a line just half-way around the earth from London, or rather from Greenwich, near London (that is 180 degrees west or east from Greenwich) and call it the date line. If you will look it up in your geography, you will find it runs north and south across the Pacific Ocean. But for many good reasons, the line taken does not run exactly north and south, but bends in places so as to dodge islands, as it would never do to have different days on the same islands, for the people would be all mixed up. There are, however, very few islands in the way. We may say, then that the days begin and end at the date line in the Pacific Ocean, half-way around the earth in either direction from Greenwich, near London.

WHAT MAKES SOME DAYS WARMER THAN OTHERS?

When we first think about it, it does seem as if the days of a week, say in June, ought to be of the same temperature (the same in heat or cold), but we know it is not so, since one day may be uncomfortably warm but the very next one so cool that we almost need a fire. No one knows all the reasons for temperature changing in this way. All the heat on the surface of the earth depends, finally, on the sun, and conditions on the sun's surface are constantly changing, never the same from day to day, and we do not understand all these changes.

One of the very latest things we have discovered is that there are places on the surface of the sun that radiate (send to us) more heat than others, and such sections constantly vary in size, form and disappear, and are not confined to the same part of the surface; consequently, the volumes of electricity and heat that constantly stream out from the sun to the earth are not the same from day to day, and thus the mysterious changes on the surface of the sun influence, in a way not yet fully understood, the warmth of the weather.

Speaking generally, the weather depends on the currents of air. We do not understand all the influences which cause the air currents to flow as they do. If they come from the north, or across large bodies of water their temperature may be greatly different from what it is if they come from the south, or across a heated desert or a level stretch of country. Does this help you to understand why it may be raining in the morning some winter day, but sleeting a few hours later, perhaps turning to snow still later, all the same day?

WHERE DID THE DAYS GET THEIR NAMES?

We name one city Chicago; another, Washington; still another, New York, so that we may know about what city people are talking. For the same reason the seven days of the week are given names. If you say, "I went fishing last Saturday," everyone knows what day you mean. All the great nations have adopted names for the days. The names are not quite the same, because, you know, people use different languages, but they generally resemble each other in sound. Just as the name "John" is not quite the same in English and German but the words used resemble each other. In this country we use the English names of the days, which are somewhat the same over all Europe, for we all form one large family of people.

Since the names go back to very old times and had to be names well known, people took for that purpose the names of some of the gods of heathen times. The sun and the moon being worshipped we have a Sun's day and a Moon's day, which have become the first two days of the week. Then there was a war god of the early Germans called Tiu, and Tuesday was named after him. Wednesday is named after Woden, Thursday after Thor, and Friday, after Frigga. These were names of heathen gods held in reverence among the people of the north of Europe. Saturday is named after Saturn, one of the Greek gods. Now you can tell the heathen god in honor of whom the day of which you read this answer was named.

WHAT MAKES IT DARK BY NIGHT BUT LIGHT BY DAY?

On a hot day you like to get in the shade because the light and heat of the sun do not directly strike you. But it is only a few feet to where the sunlight could reach you and you can see perfectly well. But suppose the shade was so big that it was hundreds and hundreds of miles to the light. It would be so dark you could not see. That is what happens at night. The earth on which we live is constantly turning round and at night you are on the side turned away from the sun. You are in the shadow of the earth, just as you were in the shadow of the house; but this time it is a very large shadow, and, as the night passes on to midnight, it gets larger and larger where you are and it is hundreds and thousands of miles to the sunlight and so it is dark. But after midnight the sunlight is coming nearer and nearer, and when morning comes the shade is gone and it is light. Where you live, when are the nights the shortest of the year? When the longest? Do you know any place where there is but one day and night during the year? Is there more than one such place?

WHAT MAKES SNOW WHITE?

Anything is white or blue or green or yellow, according to the kind of light it sends back (reflects) to the eye. Now, snow is water, to be sure, but it is water in a peculiar form. It is crystallized water. Each single snowflake is a beautiful crystal, and in the minute cells of the crystal considerable air is entangled. A great many things, when air is entangled in them, reflect all the rays of light to the eye, and so seem white, which is the natural color of light. But we must not suppose that air is always necessary to make things appear white. On lakes you notice the white caps, or breaking crests of waves. They are white for the same reason that snow is white. So is the foam on the top of soda water, or a mass of soap suds, and it makes no difference what colored soap has made it. Each single flake being white, when snow is gathered in masses, as when it lies deep on the ground, it makes everything seem to be covered with a mantle of white. Did you ever notice the crystals of snow? They are not always of the same shape. Suppose snow were naturally red in color, would it be as pleasing to the eye? Turn back and read about colored light in hospitals. Is it not an evidence of the wisdom that controls all things that snow is white? Is snow white for the same reason this sheet of paper is white?

WHY DOESN'T AN IRON SHIP SINK?

You know that iron will sink and it would seem that a ship made of iron would sink also. And it would if it were made a solid piece of iron, but an iron ship is hollow and contains much air, and the air is so much lighter than water that it enables an iron ship to float. In making an iron ship care must be used to insure that there is more than enough air space inside the ship to offset the weight of the iron. Do you think a stone ship could be made to float? Ships are now being made of concrete.

WHY DOES THE HANDLE OF A POKER GET HOT?

The reason that both ends of the poker get hot is that iron is a good conductor of heat. By the term "good conductor" we mean that iron carries heat easily. The particles of iron are very close together and when the particles near the fire get hot, they hand the heat over to the next particle, and these in turn to the next, until the handle end gets warm. What is it the particles of iron pass on? Read carefully about a current of electricity. Iron is a good conductor of electricity. Does it pass it on in the same way?

HOW DOES A TOAD CATCH FLIES?

The toad is always hungry. His gastronomic ability is so great that he must have four meals per day to be happy. He must, therefore, hunt and eat almost incessantly to get as much as he needs.

The tongue of the toad, with which he catches his food, is admirably adapted to its work. It has a sticky surface, and is fastened at the front instead of at the back. This latter fact makes it possible for the toad to throw the tongue well out of the mouth.

The toad eats almost all kinds of small living things. He sits with head bent forward and eyes looking very bright and intelligent. When he sees a fly light within two inches of his nose, he makes no preceptible movement of the head or body. The mouth opens and the fly is gone. When the fly lights farther away, the toad springs forward on his strong hind legs, then easily slips back into a sitting position. That is all we can see, but, again, the fly is gone.

HOW DOES A TOAD DRINK?

Water is necessary to the existence of a toad and they will cross a large field in search of it. Toads have been known to go a year without food and again to perish in a day without water. And yet this little creature never drinks as we drink. Instead of drinking they soak. Just like a sponge they sprawl out on their big expansive bellies and soak themselves full.

DID YOU EVER SEE A TOAD GO TO BED?

After a toad has had a fine night's hunting among the vines and bushes, and is full of bugs and worms, he proceeds at once to kick himself into bed. He backs and kicks and elbows into the loose sand as far as he can, then screws and twists till he is worked out of sight beneath the soil, hind end foremost. There he lies, with only his big pop eyes sticking out, half asleep, half awake. If a hungry snake crawls along, he simply pulls in his eyes, the loose dirt falls over them, and the snake passes on.

WHERE DOES THE TOAD SLEEP IN WINTER?

When the nights grow chilly and there are threatenings of frost, the toads hunt up winter quarters, and hide deep down in some warm burrow till it gets warm again, whether that time be tomorrow or next April. Toads and frogs are cold-blooded. that is, their temperature changes with the changes in the temperature of the air about them—hotter as the heat of the day and season increases, and colder as the air grows colder. Warm blooded animals maintain an even temperature in their blood. Thus the warm blooded animals are not so quickly affected by weather changes, but on the other hand they cannot endure the very low temperatures that the cold clooded animals can, and live. Instead of fighting the cold, the toads yield to it and soon suspend living operations altogether, all heart action ceasing, the blood in the heart even falling below freezing; yet thawing out again, and life coming back with returning warmth.

DO SOME PLANTS EAT INSECTS?

Certain plants of the pitcher plant family do eat insects. In many respects they are the most interesting and curiosity exciting of our wild plants. It would perhaps be better to say that they "absorb" insects rather than that they "eat" them. The leaves of these plants are long and tubular, and form a sort of pitcher which is generally half filled with water. The inner side of the pitcher is covered with fine hairy bristles which point downward. Just inside the pitcher is secreted a sweet, sticky substance which is supposed to attract insects. Once inside the pitcher, the insect becomes a captive, the hairs preventing its escape, and falls exhausted into the water, where it finally drowns, and its body is absorbed. Do you recall the curious flower, Jack the preacher, we met in our spring ramble? You know he was in this line of work. Mother Nature provides for the wants of all her children, but she gives boys and girls brains and expects them to find ways of supplying their own needs.

WHY DO SOME FLOWERS BLOOM ONLY AT NIGHT?

Such flowers are so constructed that they can be fertilized only by night-flying moths or by other insects which do not fly about in the daytime. Night-blooming flowers are very often large and white, to attract the insects. Here is a question for you. It seems that flowers and insects help each other out. Both are necessary for each other's well being. The flowers furnish honey or food, and the insects carry pollen. Which was first, the night flying insects, or the night blooming flowers?

WHY DOES NOT A STICK GET HOT?

A wooden stick does not get hot as an iron poker does because wood is a poor conductor of heat. No difference how hot the particles of wood that are near the fire might become, they could not pass this heat on to the next particle of wood as did the particles of iron in the poker. For this reason the handles of pokers, shovels, pots, etc., are often made of wood so as to protect our hands. Do you now see how it is you can carry a stick one end of which is on fire?

WHERE DID WE GET THE WORD "THIMBLE"?

About two hundred years ago the first thimble made its appearance in England. A metal worker made a curiously crude affair that was used for sewing. It was in the shape of a bell and was worn on the thumb. It was literally a "thumb-bell." Later on it was found that it was more effective worn on the finger, but the name clung and in its shortened form applies to our modern thimble.

HOW DOES A BLOTTER TAKE UP INK?

A blotter is so made out of very loose light paper that it has excellent ability to absorb. The thinner the liquid the more easily the blotter will absorb or take it up. Ink is nearly all water and consequently very thin and the blotter is of very loose texture and very porous so it absorbs the ink just as a sponge would do. Can you tell us why if you put a corner of a blotter into a blot of ink that the ink will run up into the blotter? What is the name of the force that draws up the ink?

WHERE DOES CHALK COME FROM?

Ages and ages ago there lived in the sea trillions and trillions of very tiny creatures. These died and fell to the bottom of the ocean, and then all of their bodies were destroyed except that part made out of carbonate of lime. This was left and kept piling up, each particle pressing against the other and the immense weight of the water above pressed over all until it became a solid mass. Thus were formed layers of chalk. Later on these layers by great changes in the earth's surface were raised until they stood above the water and were accessible to man. Do you suppose the same process is going on now in deep sees? Did you know that England was in early times called Albion, because of the great white chalk cliffs in the south shore, and that albus means white?

HOW FAR CAN A FLY FLY?

Marked flies have been known to go as far as a thousand yards, when there was no food in sight nearer. Seven or eight thousand feet seems to be their common record, but again and again they have been proved to have traveled three to four hundred yards. Is it the sense of sight or smell that guides flies to their food?

WHY DOES A PENCIL WRITE?

You can use a pencil to write with or to make marks, because the pencil wears off if you are scratching it on a surface that is rough enough to make it do so. Writing, you know, is only a way of making marks in such a manner that they mean something. You cannot write with a pencil on a pane of glass, because the glass is so smooth that when you move the pencil over its surface, the pencil will not wear off. To prove to yourself that the tip of the pencil constantly wears off when you write, you have only to recall that when you write with it a pencil keeps getting shorter and shorter. A slate-pencil will wear down short by merely writing with it, but a lead-pencil must be sharpened—that is, you must keep cutting away the wood in order to get at the lead inside. But is it lead inside a lead-pencil?

WHY CAN'T I WRITE ON PAPER WITH A SLATE-PENCIL?

You cannot do so, because it takes something with a rougher surface than paper to wear off the point of a slate-pencil. A slate is used with slate-pencil, because slate wears off the end of the pencil easily, and also because you can rub out the writing on a slate with water. Lead-pencils are used for writing on paper, but you must have a rough surface on the paper to write on even with a lead-pencil. Some kinds of papers have such a smooth surface that you cannot write on them with a lead-pencil. Can you write on glass with a lead-pencil?

WHY DOES AN ENGINE PUFF WHEN IT IS STANDING STILL?

Because an automatic pump is at work filling the air-brake tanks with compressed air. Just after a train has come to a standstill the compressed air is pretty well exhausted from operating the brakes under each car of the train, and the puffing of the air pump is rapid. As the tanks fill, the pumping gradually becomes slower. Is the air that you breathe compressed at all? By what? Would an engine work harder on top of the Rocky Mountains than at the sea shore?

HOW DID THE UNITED STATES GET THE NICKNAME OF "UNCLE SAM"?

During the war of 1812 our Government had a contract with Elbert Anderson to furnish army supplies, and the inspector appointed to pass on the goods was a jolly man known as "Uncle Sam," his name being Samuel Wilson. He inspected the boxes, and if they were all right marked them with the letters "E. A.—U. S.," the initials of the contractor and the United States. When the marker was asked one day what these letters stood for, he jokingly replied, "For Elbert Anderson and Uncle Sam." This was spread as a good joke, and it became common to refer to all packages marked U. S. as belonging to Uncle Sam.

WHY DO WAVES BREAK ON THE SEA-SHORE?

Water in motion will always dash against any resisting surface and fall back. On a long, sloping beach the friction at the base of a wave will retard it, so that while the top is moving along, the bottom is held back. This makes the top of the wave curve in a crest which will finally fall over and break. In breaking, the crest lets in air particles which make bubbles of white foam.

HOW DOES A TALL TREE CARRY WATER UP TO ITS TOP?

This is a very difficult question and botanists are not agreed as to just how the water is carried up to such a height. It cannot be by ordinary pumping action, because a pump will raise water only twenty-eight feet. The force of "capillarity," which makes oil rise in a lamp wick, cannot pull water up so high. The living cells in the wood and in the leaves are probably able to form in some way a series of little pumps and thus to draw the water up very high.

WHAT IS THE ORIGIN OF THE NICK-NAME "BROTHER JONATHAN"?

Once when General Washington needed ammunition, he called a council of officers, and when no one had any suggestion to make, he said, "We must consult Brother Jonathan," referring to Governor John Turnbull of Connecticut. This patriot helped them out; and afterwards in emergencies it became common to say that "Brother Jonathan" must be consulted. Gradually the government itself was called "Brother Jonathan." By the way, during what war was this?

HOW DO ANIMALS SLEEP?

All animals sleep, but many of them in ways so curious that they seem to be awake. Ducks sleep on open water, and to keep from drifting ashore paddle with one foot continually, thus traveling in a slow circle. Bats sleep head downward, hanging by their hind claws. Some birds sleep with their heads turned backward and tucked under their wings. In addition to their eyelids, owls have a curtain which they draw sidewise over their eyes. Many animals of the cat kind sleep with wide-open, staring eyes. Elephants sleep standing up, their heads slowly swinging as if they were awake. It is these and other curious attitudes that give rise to the stories that some animals do not sleep.

CAN YOU SEE THE WIND?

You have probably noticed the quivering air rising from a hot stove or a steam radiator or even from the road on a very hot day. You were seeing the air then. If you want to see the wind, take an ordinary saw and hold it with toothed edge upward and across the wind. Then squint along the edge of the saw, and you will see the same quivering effect that is mentioned above; this is the wind passing over the saw edge.

WHAT MAKES ROSES RED?

All roses are not red. Some are white and others pink or of still another color. The color of the rose, and in fact the color of all flowers is due to the way they absorb and reflect the sunlight. In the case of the red rose, the something in the plant that determines the color, absorbs all the other colors in the sunlight and reflects the pure red rays and that makes the color of the red rose. Just as flowers can be trained to secrete an agreeable perfume, they can be induced to vary their color. Can you see any reason why brilliantly colored flowers grow more readily in the tropics?

WHERE DOES THE ROSE GET ITS SWEET PERFUME?

The perfume arises from an oil which the plant secretes and just as there are many kinds of flowers, so almost every flower has a different smell. Of course, flowers belonging to the same family or species are likely to develop similar odors. The oils produced are what are known as volatile oils, which means "flying oils," because, if extracted from the flower and placed in a bottle with the cork left out, they will vanish into the air. Without this quality we could not, of course, smell them at all. Did you know flowers could be trained to develop odors? The dahlia does not have an agreeable odor but by selection, a fragrant one has been developed. All perfumes are not pleasant but may attract such insects as flies.

WHY DO FLOWERS HAVE PERFUMES?

Man uses these oils to provide himself with perfumes, but the plant or flower has another purpose than this. The perfume is not made for man's use, but for the use of the plant itself. In the plant and flower world the smell of the plant which is in the flower is a part of the scheme whereby plants reproduce themselves. In order to do that flowers must produce a seed. The flowers are in most cases the advance agent of the coming seed. Each flower produces within itself a little powder callen pollen. Flowers will not do well unless they exchange their pollen with that of other flowers of the same species. And to do that they must enlist insect messengers such as bees, moths and butterflies in their service. The perfume is one means flowers employ to call messengers to their service.

HOW DOES A PEN WRITE?

Writing with a pen, however, is quite different from writing with any kind of pencil, because in writing with ink we do not wear off the end of the pen, but the ink flows from the pen on the paper. For this purpose we must have a surface that will absorb the ink from the pen, draw it from the pen, and make it flow. A slate has no power of absorption and therefore cannot draw the ink. A piece of blotting paper is the best kind of paper for absorbing ink, but it is too much so for writing purposes. For writing with ink we need a comparatively hard surfaced paper that has absorbent qualities, but not too absorbent.

WHY DOES A BARBER'S POLE HAVE STRIPES?

In early years the barber not only cut hair and shaved people, but he was also a surgeon. He was a surgeon to the extent that he bled people. In early times our knowledge of surgery was practically limited to blood letting. A great many of the ailments were attributed to too much blood in the body, and when anything was wrong with a man or woman, the first thing thought of was to reduce the amount of blood in the body.

The town barber was the man who did this for people and his pole represented the sign of his business. The round ball at the top, which was generally gilded, represented the barbering end of the business. It stood for the brass basin the barber used to prepare lather for shaving customers.

The pole itself represents the staff which people who were having blood taken out of their bodies held during the operation. The two spiral ribbons, one red and one white, which are painted spirally on the pole, represent the bandages. The white one stands for the bandage which was put on before the blood was taken out and the red one the bandage used for binding up the wound when the operation was completed. Do physicians nowadays believe in bleeding people when they are sick? What is the blood for? Will nature make too much blood?

HOW CAN SOME PLANTS CLIMB A SMOOTH WALL?

To answer this question, we should pick out a plant like the creeping ivy vine. If we examine the same as it climbs a brick wall, we find that it sends out little shoots which attach themselves around the little rough places in the bricks of the wall which, if examined under a microscope are quite large apparently—at least they are large enough for the tiny creepers of the ivy to hold on to. Of course, if there were only one little "shoot" to reach out and take hold of the rough spots in the wall it could not support the vine, but the vine puts out a great many of these shoots perhaps best called "clingers," which holding on together enable a quite heavy vine to hang on to an apparently smooth wall. Do hop vines and twining plants depend on this same principle?

WHY DOES AN ONION MAKE THE TEARS COME?

The purpose of tears is to wash the eye. Every time you wink a little tear is released from under the eyelid and the wink spreads it all over the eyeball, washing the ball perfectly clean. Then the tear runs along a little channel at the lower part of the eye and out through a little hole into the nose, thus keeping the nose moist so that we can breathe and smell better. When an onion is cut it throws off tiny particles and these striking the eye irritate it and nature, to protect the delicate organism of the eyes, sends more tears to wash them and protect them. Sometimes so many tears come that the little channel and orifice into the nose cannot carry them all away and they overflow onto the cheeks. What do we call it then?

WHY DO COATS HAVE BUTTONS ON THE SLEEVES?

There was a time once when handkerchiefs were not in universal use and when people had bad colds they used their sleeves as we would now use our handkerchiefs. An old king once had an idea of dressing some of his soldiers up in a very fancy uniform, but he soon noticed that they were using their sleeves for handkerchiefs. He immediately decreed that rows of buttons should be sewed on the sleeves so that whenever a soldier attempted to use his sleeve as a handkerchief the buttons would scratch his nose. These buttons were ornamental and it soon became a fad to sew them on every coat. After a while when handkerchiefs were commonly used some one placed the buttons on the back of the sleeve and left off all but two or three, and that is the way the tailors have been sewing them ever since.

WHAT ANIMAL IS CONSIDERED A WEATHER PROPHET?

Early in the autumn the wood chuck (or ground hog) goes to sleep in his winter quarters. He curls himself up in a little ball, with his nose under his paws so that he can keep his toes warm by breathing on them. Here he sleeps snugly all winter, and then, so the story goes, he wakes up suddenly on February 2, stretches himself, rubs his eyes, and at last creeps out of his cozy nest to see what it looks like outdoors. If he finds it cold and wet, the earth covered with snow, and heavy gray clouds hanging low in the sky, he begins to look around, for he feels certain that soon the ground will be warm, and the little birds will be coming out, for Spring is surely on her way. But if the sun is shining brightly and the first thing he sees as he leaves his burrow is his own shadow, he pops back into it as fast as he can, once more tucks his nose under his paws, and settles down for another six weeks' nap, for a cold late season is the only result that can be expected. It must be confessed that he dosen't always get it just right, but then the very best of us make mistakes at times.

ARE GUINEA PIGS REALLY PIGS?

Perhaps many of you have read that interesting book called "Pigs is Pigs," or maybe you have seen it in moving pictures. But, guinea pigs are not pigs at all, and there is no reason for giving them such a name. They are properly called "cavies," and they came originally from South America. Do you know of any other somewhat similar mistake. Is a seal a fish? Is a bat a bird? Is a pineapple an apple?

WHAT INSECT LIVES IN A HOUSE MADE OF BUBBLES?

In every field and meadow during June and July, bubble houses may be seen attached to the stems of grasses or weeds. Underneath each pile of bubbles, with its beak embedded in the stem, a little green bug is sucking the juices of the plant. He takes in such quantities of sap that it oozes out all over his body in little bubbles. This protects him from the sun until he has grown into a mature "frog hopper."

WHAT INSECT LOOKS LIKE A LOBSTER AND TAKES LONG JOURNEYS ON A FLY'S LEG?

The false scorpion, a tiny insect no larger than a pinhead, lives in dusty corners among old books and papers. He has a great passion for traveling, and when the first roving fly comes near, he will at once seize one of the fly's legs with his long lobster-shaped claws, and go sailing off through space dangling from the fly's foot.

WHAT FISH LAYS ITS EGGS ON A ROCK AND THEN GOES TO LIVE IN AN OLD TIN CAN?

After the female toadfish has laid her eggs, she finds some old tin can, or even an old shoe, crawls in, and with her mouth at the opening, stays there for the rest of the season, leaving her family to shift for itself.

WHAT DUCK LAYS ITS EGGS IN TREES?

The wood duck makes its nest in the limbs of a tree near a pond or stream and hatches its young there. The manner in which the ducklings are transported to the water has long been a question in dispute, but within a few days they are to be seen swimming. This duck is the most beautiful duck found on the American continent and much resembles the mandarin duck of the Orient.

HOW MUCH WOOL IS THERE IN A SUIT OF CLOTHES?

Most people believe that it is the cost of the wool in a suit that makes it so expensive. This is hardly true. It has been estimated that to make a man's medium weight pure wool suit, it takes about nine pounds of wool. If you will look in your daily newspaper and see what wool is worth today you will see that it is only a small part of what you are compelled to pay for a suit of clothes. Where does the wool used in clothing come from? What is the difference between cotton and wool? Did you ever hear of asbestos? See what you can find out about it and why it is sometimes called mineral wool?

WHY DO I FEEL SLEEPY AFTER EATING A HEARTY MEAL?

As soon as food is taken into the stomach, all the blood that is not needed elsewhere rushes to help digest the food, and to carry the nutritive results of digestion to all parts of the body. It is drawn from the brain, which relaxes. The brain never makes us feel sleepy when it is full of blood. For this reason it is best not to over-exert the mind or the body immediately after eating, but to allow the stomach some time to properly digest the food.

WHAT IS THE ORIGIN OF THE CUSTOM OF LIFTING THE HAT?

In the days of Chivalry a knight always wore full armor in public. It became a custom for a knight when entering a company of friends, to remove his helmet, signifying that he was safe while in their presence. Later on when the hat displaced the helmet, the custom remained and that is why we lift the hat today. You should now read about the Age of Chivalry.

WHAT INSECT RIDES IN A BALLOON THAT HE MAKES HIMSELF?

Spiders, especially the smaller ones, as all other animate things have the wanderlust, and construct remarkable vehicles to carry them on their voyages. When a spider's ambition turns to ballooning, it hies away to a fence post, a twig or it may be the top of a golden rod. Our spider takes a firm hold with its legs and commences spinning silken threads. If atmospheric conditions are right these fine threads will float upward and when the pull is sufficiently strong the spider grasps them firmly with its feet and goes sailing upward and away on the breeze.

WHAT INSECTS KEEP SLAVES?

Very frequently ants have slaves to work for them. Large colonies of warrior ants sometimes make raids upon neighboring cities of other species, defeat them in pitch battles and carry home their young to be raised as slaves. Ant wars are not pink tea affairs but are bloody conflicts. Many a head is ripped off, and many a soldier ant limps home-ward after the fray minus one or more of his legs.

WHY AND HOW DOES A FIREFLY GLOW?

In our yards we often see the firefly, or lightning bug, and probably most have wondered how and why it produces its light. The firefly is a kind of a beetle. Only the female has a light and she shows this in order to attract the male. The light giving organ consists of a fatty tissue supplied with numerous air tubes and nerves; the nerves stimulate the air tubes and the latter convey oxygen to the fatty tissue but the process by which the light is produced is not understood. The inventor who masters that secret will have a fortune in his grasp.

WHY DO WE USE OUR RIGHT HANDS WHEN SHAKING HANDS?

In the olden times all men went fully armed and were ready to fight at any time.

Guns were not in use then, and the sword was the common weapon. Then, as now, most people were right handed, so the sword was carried in the right hand. When two men met it was necessary that each should know whether or not the other was peacefully inclined. If one on approaching would extend his right hand so that the other could see that it contained no weapon, then if he too wished peace he would extend his right hand weaponless to show that he accepted the truce. By clasping hands neither could change his mind and assume a fighting attitude without fair warning.

HOW DID SHAKING THE HEAD COME TO MEAN "NO"?

The origin of this method of indicating "No" is found perhaps in the result of the mother's efforts in the animal kingdom to feed her young. A mother animal would be trying to get her young to accept the food she brought them and would try to put it in their mouths. Perhaps, however, the young animal had had sufficient food or did not fancy the kind of food offered. The natural thing to do under the circumstances would be to close the mouth tight and shake the head from side to side to prevent the mother from forcing the food into its mouth. Thus we get the closed lips and the shaking the head from side to side meaning "No" came from an effort to say "I don't want any."

HOW DID A NOD COME TO MEAN "YES"?

The idea of nodding to mean "Yes" comes from the opposite of the action which, as just described, indicated a "No." If the young animal was anxious to accept the offered food, it would make an effort to get at it quickly. Hence, the pushing forward of the head and the open mouth (always more or less opened) when you nod to indicate "Yes" and an expression of gladness. You will notice if you see anyone nod the head to indicate "Yes" that the lips are open rather than closed, and that there is always a smile or an indication of a smile to accompany it. In other words, the nod to mean "Yes" is only another way of saying "I shall be pleased."

WHAT KEEPS A TRAIN OF CARS ON THE RAILS?

A great many boys think they know the answer to that question. They will say it is because of the rim, or flange, that is on the inside edge of the car wheel. That rim merely steadies the car—keeps it running smoothly. But notice the next time you go to the railway station, that the rail is not flat on top. It is slightly rounded. If a freight car is standing on a side track you will see that the rim of the car wheel is not flat either, and it does not rest squarely on the top of the rail. Besides having a ringlike flange on the inner edge, the broad rim of the wheel slants much like a cork that is made smaller at one end so it can be pushed only part way into a bottle. The outer circumference of a car wheel is smaller than the inner. And the wheel rests on the inner slope of the rounded rail.

WHY DOES SALT MAKE YOU THIRSTY?

At all times there is present in our bodies a certain amount of salt. Many animals—horses, cattle, sheep—also need salt and will go a long ways to get it. Salt is necessary for our well being and as long as this amount is not materially increased we do not feel that we have too much salt. However, when we eat too much salt the body calls for water or something to drink in order to dilute or counteract it. It is merely nature's way of keeping in the body the right proportions of all the different elements so that we may have perfect health. You are generally thirsty when you eat considerable candy, is it for the same reason?

WHAT CAUSES LEAVES TO FALL IN THE AUTUMN?

Leaves do not fall through the action of frost alone. During August and September a thin layer of corky cells forms at the point where the leaf stem joins the twig. As the season advances this layer separates into two circular layers, leaving only the central bundle of veins to hold the leaf. Then, with the first strong wind, or a frost, this bundle is torn apart and the leaf falls. You notice that the leaves have done their year's work. They have supported the life of the tree, provided for its growth, not until then are they dismissed by Mother Nature from her service.

WHY DO SOME BULBS BLOOM IN WATER WITHOUT EARTH?

Some bulbs, like the narcissus, are very large in proportion to the rest of the plant. They are packed with food material, and when the bulb is put in water, and thus provided with the necessary moisture, they have sufficient food elements to produce leaves and blossoms without soil.

WHY DOES BOILING WATER STAY AT THE SAME TEMPERATURE INSTEAD OF BECOMING HOTTER?

After the boiling point is reached, all the heat is used in changing the water into steam. More than five hundred times as much heat is required to change a given quantity of water into steam as to warm it one degree Centigrade. Do you have a gas stove in your house? When the water in which potatoes are placed is boiling, will they be done sooner by turning the gas up?

WHY DO WEEDS THRIVE BETTER THAN CULTIVATED PLANTS?

Weeds are plants which have had to shift for themselves ever since Mother Nature formed them, and only those which were well able to take care of themselves have survived. Cultivated plants have always been taken care of by man, and are therefore much less hardy. It is much as if Mother Nature says, "if you want my plant children to produce fruits and grains for you, you must take good care of them. I will turn that part of my work over to you."

HOW CAN THE MISSISSIPPI RIVER FLOW UPHILL?

The source of the Mississippi is so far north that it is in the region where the flatness of the poles begins. Accordingly this region is not so far from the earth's center as the region at the mouth of the river much further south. So, of course, as the river flows south it flows farther and farther from the center of the earth, or up hill. It is able to do so because the farther south it goes, the faster the surface is turning around under it and the water tends to fly away from the center.

HOW CAN THERE BE HOT SPRINGS IN ICELAND?

Part of Iceland is of volcanic origin, and in several of the mountains eruptions have occurred within the last four hundred years. In the southwest, in particular, there are many hot springs, over which food can be cooked. Do you know of any of our states that possess hot springs? The temperature of the surface of the earth affects the crust for a short distance only; volcanic actions come from deep within the earth, and are not influenced by conditions on the surface.

HOW CAN A SOUND BREAK A PANE OF GLASS?

We all know that a sudden jar will break a flat piece of glass. Sound waves caused by an explosion of dynamite or some similar violent disturbance will sometimes break against a window miles away with sufficient force to shatter the glass. This means that the vibrations of the air have carried the effect of the commotion faster and farther than it has been conveyed by the solid particles of the ground.

WHAT ANIMAL CARRIES ITS HOUSE ON ITS BACK AND HAS EYES ON THE ENDS OF ITS HORNS?

The snail has on its back a shell into which it can withdraw its body, and at the tips of its two longest stalks or horns are found its eyes. The shell of the snail is made and mended by a juice from its body which is at first sticky and then hardens into shell. How do you think the snail pulls himself into the shell? Have you a rubber glove? You can push a finger part back into the hand part, and then you can crowd it all into a small ball. In the same way, the snail can pull his head part and his horns into his stomach part and then by means of strong cords draw it all up into the shell. Do you see why the snail is called a stomach walking animal?

WHY DO FARMERS PLANT CLOVER ON A FIELD AND THEN PLOW IT UNDER?

On the clover roots are colonies of tiny bacteria, which are able to take nitrogen directly from the air and to convert it into valuable plant food. Ordinary plants cannot take their nitrogen from the air, but must get it in the form of salts from the soil. You will be interested in reading about fertilizers in agriculture.

HOW IS AIR MADE LIQUID?

It is hard to believe that the air which we breathe can be changed into a liquid, and yet liquid air is in frequent use in chemical laboratories. We are familiar with the idea of changing water to a solid by cooling it or to a vapor by heating it. All matter is in a solid, liquid, or gaseous state according to temperature and pressure, and substances differ widely in the degree of heat or cold required to change them from one state to the other. Air is a mixture of gases and may therefore be liquefied, but it must be cooled to 310 degrees Fahrenheit below zero, and subjected to pressure. Thus while water to become a gas must be heated to 212 degrees Fahrenheit above zero, air must be cooled to a temperature even farther below zero, to liquefy it. To achieve this low temperature, use is made of the fact that when a gas expands rapidly it loses heat. The air is compressed to a very high pressure and then allowed suddenly to expand, thus cooling it. Doing this once would not reduce the temperature sufficiently, but by letting the cooled air on its way out from the vessel pass over the pipe through which more air is entering, the incoming air will be cooled to a point where, when it in its turn expands, above five per cent of it will liquefy.

HOW CAN AIR BOIL?

In the problem of storing this liquid air we come across another of its astonishing properties. Its boiling point is 310 degrees Fahrenheit, below zero. Even with the slight amount of heat that will reach it in a double-walled flask made on the principle of a thermos bottle with a vacuum between the walls it will promptly begin to "boil." So fast will it boil—away down three hundred and more degrees below our freezing point of water—that, if an outlet were not left for the escape of the gases given off in boiling, it would blow the vessel to pieces. Even with the utmost care, all of the liquid air in the vessel will boil away in a few days.

WHEN WAS THE MAGNETIC COMPASS FIRST KNOWN IN EUROPE?

During the twelfth century it was brought to Europe by Crusaders, who had obtained it from Arabian traders in Eastern waters. When first brought to England, no one dared to use it, lest he should be accused of witchcraft. It was also thought that sailors would not go in a ship whose captain had an instrument, which, from its strange and wonderful qualities, might possibly be the work of evil spirits. The compass came into general use late in the thirteenth century.

HOW ARE PINS MADE?

It is hard to realize that it has taken many years to perfect so simple a thing as our common pin. But in the old days pins were very far from being common. In Egyptian tombs we find pins with gold heads. In Greece and Rome clasps and buckles were used. But during the Middle Ages people used lacings of leather, thorns, and slivers of wood, bone, ivory, and shell to fasten their clothes. Pins were such a luxury that it was the custom to give a bride "pin money"; that is money with which to buy pins, a custom from which we get our phrase.

The first pins were made of brass and bent and twisted badly. Furthermore, they were very expensive, as they were all made by hand. Now, thanks to American inventors, the first of whom is said to have been Lemuel Wright, who in 1831 invented a machine for making pins, most pins are made entirely by machinery.

The basis of the common white pin is brass wire, which is clipped to the required length and pointed. It then travels on a machine which flattens the head by jamming the end against a heavy weight. Next the head is shaped and rounded off. The pins are then cleaned in barrels of sawdust and put into kettles containing a mixture of tin and nitric acid, where they are boiled until each is coated with a thin silvery covering. After being polished once more in barrels of sawdust, they are ready to be set in papers and sold.

Common black pins are made from brass, which is boiled in Japan varnish instead of being tinned. For the best grade of black pin, steel is used, the beadlike tops being made by dipping the heads of the pins in a solution of liquid glass.

It is an interesting fact that the United States is the largest pin manufacturer in the world, and that the people of the United States use more pins than any other nation.

HOW CAN A SOUND GO THROUGH A WALL?

When a sound wave, traveling through the air, reaches a wall, it communicates itself to the wall and throws it into waves of exactly the same shape and number in each second. The waves in the wall though are slightly smaller than those in the air, for some power is lost in the transfer. The waves after traveling through the wall are communicated to the air on the other side, but there is still another loss of power. If the wall is very thick or composed of some material that is not a good conductor of the vibration, the sound wave will be much weakened or perhaps entirely overcome.

WHY DOES A CAT ALWAYS FALL ON ITS FEET?

The cat is by nature a climbing animal, and as such has acquired the instinct of adjusting its motions so as to fall on its feet. It is by its quickness that it is able to accomplish this truly remarkable feat. A cat cannot fall from a great height, though, without injury, and no animal fears falling more.

HOW DOES A CAT PURR?

Purring is caused by the breathing of the cat when her body is entirely relaxed. Such relaxation occurs only when she is satisfied. Thus cats purr while eating, when going to sleep, or when petted, if they have no fear of being disturbed. But lions and tigers are only big cats, can they purr? The next time you visit a zoo garden, ask the attendant.

HOW ARE NEEDLES SHAPED?

It used to be said that before a needle was finished one hundred persons had had a share in fashioning it. Machines have recently done away with much of the handling of needles, but the process is the same.

Needles are made from "blanks" or lengths of fine steel wire. These blanks are cut in pieces just long enough for two needles. Each end of the piece is sharpened by being ground down to a fine, flawless point. The middle of the piece is next flattened, and the spots are indicated where the eyes of the two needles are to be punched. When the holes have been made, a wire is run through the two eyes to hold the needles firmly in place, and the steel is bent until it breaks in halves. The needles are then heated, tempered to the necessary strength and hardness, and polished.

HOW ARE HOOKS AND EYES MADE?

Hooks and eyes are made from brass wire; this is because brass does not rust as would other material. They are often a by-product of pin making, being made at the same factories from material that will not do for pins. The wire which comes on reels is drawn into a machine by nippers and is there clipped off to the necessary length. One machine makes only the hooks and another the eyes. After the wire is cut to the right length, it is flattened and twisted into the desired shape. The brass hooks or eyes are then put into a kettle, where they are silvered or tinned in a solution of melted metal. If they are to be black, they are japanned with black varnish and then dried. After they are made, they are sewed upon cards and are ready for the shopper.

WHY DO CHILDREN CRAVE SUGAR?

Sugar is the food best fitted of all for quick use in the body. All of the things we eat are for the purpose of supplying energy to replace that which our daily activities have dissipated. Many foods have but little value as producers of energy, and others are not available for immediate conversion into energy, but sugar is actually turned into real energy within a few minutes after it is eaten. Most children are very active and use up a great amount of energy. They are therefore, always in need of food that can quickly be converted into energy, and as sugar answers this requirement better than any other food, Mother Nature gives children a craving for it.

HOW CAN YOU PIERCE A COIN WITH A NEEDLE?

To pierce a penny or a nickel with a needle, if the needle is a fine one, would seem to be an impossible task. It is really a very simple matter, and the only apparatus needed is a cork, a needle, and a hammer. If possible, select a needle just about the same length as the cork. Stick the needle through the cork in such a way that the point just protrudes; if the other end of the needle projects above the cork, cut it off with a pair of pincers or heavy shears. After placing the coin and cork on two small blocks of wood, hit the cork a vigorous blow with a hammer. The cork prevents the needle from bending, and the blow of the hammer therefore forces the steel point right through the softer metal.

HOW CAN YOU MAKE A TUMBLER SLIDE?

Place a glass face down on a marble slab, one edge of which is slightly higher than the other. Before placing the tumbler on the marble surface, soak its rim in water so that the entire rim is quite wet. The glass will remain at rest. But if you place a lighted candle close to the tumbler, and keep it there for a moment or two, you will see the glass begin to move and slide along, as if it were propelled by some mysterious force.

What causes this phenomenon? The heat of the candle expands the air in the tumbler and raises it slightly, but the film of water round the rim prevents the escape of the air, and the glass, no longer resting on the marble, but on a thin layer of water, follows the inclination of the slab and slips along its entire length.

WHAT LITTLE ANIMALS CLING TO THEIR MOTHER'S NECK WHEN SHE FLIES?

Bats never make any nests or even attempt to fix over the crannies where they hide or where the little bats are born. But the little ones are not left at home at the mercy of foraging rats and mice. When the old bat flits off into the twilight the youngsters often go with her, clinging about her neck, swinging away over the tree tops, while she chases the numberless little flying things of the dark.

WHY DO I FLOAT MORE EASILY IN SALT WATER THAN IN FRESH?

Because salt water is slightly heavier than fresh water. The body sinks only low enough to displace an amount of water weighing just what the body weighs, and thus will not sink as far in salt water as in fresh. In the Dead Sea or in Great Salt Lake where there is a great amount of salt in the water it is very easy to keep afloat. How did the water in Great Salt Lake become so salty? Why doesn't Lake Michigan get salty? There are immense salt deposits near Salt Lake, do you think the lake was once larger? You will be interested in reading the graphic discussion of Utah.

WHY DON'T A SQUIRREL'S TEETH WEAR OUT?

Our parents and teachers continually warn us that we must not bite hard things with our teeth, or they will break or wear out. But how is it that the squirrel can gnaw hard wood or nuts all of its life and still have good teeth? When our teeth are fully developed they stop growing, and any part that may be broken off or worn out is not replaced, but in that class of animal called rodents, or gnawing animals, the teeth keep right on growing and no matter how many nuts a squirrel may bite he need have no fear of wearing out his teeth. If one of the incisors be broken off, its opposite continues to grow, in which case at length it locks the jaw and the squirrel starves to death.

WHAT IS "WHITE COAL"?

"White coal" is a name often given to waterpower, because it is taking in a large measure the place of steam power supplied by the burning of coal. In many places the force of falling water drives gigantic water wheels and produces hundreds of thousands of horsepower in energy. Only a very small percentage of the waterpower of the world has as yet been harnessed but as coal becomes more expensive and more difficult to obtain, more and more of the power now going to waste in our rivers and lakes will be utilized. You will be interested in reading about the development of "white coal" in New England and Montana and especially of Niagara.

WHERE DID THE NAME CALICO COME FROM?

A fabric of cotton cloth, the name being derived from the city of Calicut, in Madras, where it was first manufactured, and in 1631 brought to England by the East India Company. Calico-printing, an ancient Indian and Chinese art, has become a great industry in this country and in Britain, as well as in Holland. (Read the Story of Cotton.)

WHAT MAKES A MATCH LIGHT WHEN WE STRIKE IT?

The match lights when we rub it along a rough substance, because the rubbing produces sufficient heat on the end of the match to set fire to the head, as we call it, which is made of chemicals that light more easily than the stick of wood forming the rest of the match. The fire thus started is hot enough and burns long enough to set fire to the wooden part of the match.

To explain this more fully, let me say this. Rub your finger quickly along your coat sleeve or along your trousers, pretending that your finger is a match. You find the end of your finger becomes warm, don't you? Not warm enough to set your finger on fire, of course, but if you had the same combination of chemicals on the end of your finger that there is on the match, you would set the chemicals afire and this would burn your finger, just as it sets fire to the wooden part of the match.

It took a great many years to discover the combination of chemicals of which the head of the match is made. Before that discovery was made it was far from easy to light the light in the evening as it is now. Do you use any safety matches? Can you find out why they will not light unless you rub them on the box?

WHAT ANIMAL HAS A LIVING CRADLE IN WHICH TO CARRY ITS YOUNG?

When the little opossums are born they only weigh four grains. Think how much that is. For there are seven thousand grains to one pound, which means that it would take 1750 baby opossums to weigh as much as two cups of sugar. It is quite evident that such tiny creatures could not make their way in the outside world, so the mother opossum has a pouch or false abdomen into which they are immediately transferred, and in this living cradle they remain till able to take care of themselves.

WHY CAN YOU BLOW OUT A CANDLE?

When you light a candle it burns, because the lighted wick heats the wax or tallow sufficiently to turn it into gases, which mix with the oxygen in the air and produce fire, the effect of which we see as light. You know it is not easy to light a candle quickly. You must hold the lighted match to the wick until the body of the candle begins to melt and change to gases. As long as the wax or tallow continues hot enough to melt and turn to gas the candle will burn until burned up; but if there be a break in the process of changing the wax to gas, the light will go out. Now, when you blow at the lighted candle you blow the gases which feed the flame away from the lighted wick, and this makes a break in the continuous flow of gas from the wax to taper, and the light goes out. Is the light from a burning candle and from a red hot iron the same? Why don't the iron burn up? Why don't you blow out gas?

WHY DOES IRON GET RED HOT?

When a piece of iron is sufficiently heated, it gives off light. Getting red is only one stage in this development by heat to the point where it makes its own light. If you heat it still more, it will give off a white light, and if you continue the process it will melt and change its form. In big iron mills those experienced can tell from the color of the light given off when it is sufficiently heated to make the best steel.

WHAT CAUSES HAIL?

Hail is the name given to the small masses of ice that sometimes fall in showers, and are called hailstones. When a hailstone is examined it is found to consist usually of a central nucleus of compact snow, surrounded by successive layers of ice and snow. Hail falls chiefly in spring and summer, and often accompanies a thunderstorm. Hailstones are formed by the gradual rise and fall, through different degrees of temperature (by the action of windstorms), and they then take on a covering of ice or frozen snow, according as they are carried through a region of rain or snow.

WHERE DO TEARS COME FROM?

Tears are not made only when we cry. They seem to come only when you cry, because it is then that they spill over on the cheek. A little gland is secreting tears all the time, and your eyes are constantly washed with them. You have often noticed that you wink every few seconds. You have often tried to keep from winking—to see how long you could do so. Boys and girls often do that. When you keep from winking what seems a long time, you notice that your eyes ache and feel very dry just before you have to let them wink, in spite of yourself, and just when you think you are not going to.

WHERE DO THE TEARS GO?

Of course, if they are coming all the time you wish to know where they go. Look right down here at the inner corner of my eyelid, there you will see a little hole. That is where the tears pass out of the eye when they have washed the eyeball. Where do they go then? Did you ever notice that soon after you cry you have to blow your nose? The reason is that when the tears go through that little hole they run down into the nose where they serve to keep it moist. Making tears and winking go on all the time while you are awake, and they are continually passing from this little opening. But when is to be open, flat, and spread out to its full length. When you wind a watch you coil this spring, that is you bend it out of its natural shape. As soon as you have wound it the spring begins to uncoil itself, to get back to its natural state. That is the power which makes the watch go. Men who make watches arrange the spring and the other machinery in the watch in such a way that it will uncoil itself only at a certain rate of speed. Sooner or later the spring loses its elasticity and its power to make the watch go. Some clocks have springs, others have weights, in this latter case what causes the works of the clocks to go?

WHAT CAUSES RAIN?

With regard to rain, it may be said, in popular language, that under the influence of solar heat, water is constantly rising into the air by evaporation from the surface of the sea, lakes, rivers, and the moist surface of the ground. Of the vapors thus formed the greater part is returned to the earth as rain. The moisture, originally invisible, first makes its appearance as cloud, mist or fog; and under certain atmospheric conditions the condensation proceeds still further until the moisture falls to the earth as rain. Simply and briefly, then, rain is caused by the cooling of the air charged with moisture.

WHY ARE YOUR FINGERS OF DIFFERENT LENGTHS?

There is no known reason why our fingers should be of different lengths today; in fact it is thought by some people that the hand would be stronger if the fingers were all the same length. Certainly, however, the hand would not then be so beautiful and it might not be so useful. Mother Nature never makes a mistake. The human hand today is perhaps the most versatile thing in the world. You can do more things with the hand than with any other one thing in the world. The probability is that the shape of the hand today and the length of the fingers are the result of the different tasks demanded of the hand during its period of development. We must go back to the time, however, when men walked on fours, for that is probably the real explanation. Originally man's fingers were of different lengths because all four-footed animals had the same peculiarities. The shape and length of the toes and their arrangement for giving the proper balance and support to the body, and in moving about and in climbing produced the best toe hold. Is the thumb a Finger? If you had to lose one of your fingers which would you prefer to part with?

WHY WAS THE THISTLE CHOSEN AS THE NATIONAL EMBLEM OF SCOTLAND?

The story is told that long ago during a Danish invasion of Scotland when a party of Danes attempted to surprise a Scotch encampment during the night one of them stepped upon a thistle and uttered a cry of pain. The sound awakened the Scots and they defeated the invaders and ever since the lowly thistle has borne a high place in their affections.

WHY DOES BURNING WOOD CRACKLE?

Wood is a fibrous substance and between the fibers there are little spaces called "cells," filled with moisture, with air, or with other gases. When the stick of wood becomes heated by the flame of the fire, the moisture or the air in the cells becomes heated and expands with explosive force, tearing down the thin partition of fiber on the outside, and thus permitting the gas to escape. A variety of noises is heard; little pops due to the explosion of the gas, and cracklings due to the tearing asunder of the fibers of the wood.

WHY DO PLANTS NEED SUNLIGHT?

Most plants, if placed where no light from the sun can reach them, will die very quickly. To prove that a plant needs the sunlight, we have only to place it in a dark corner of the cellar and notice how soon it dies. In fact, if it were not for sunlight there would be no life on earth at all. The plant or tree drinks in sunlight through the surface of the leaves. In fact the ability to take in sunlight constitutes the real life of the tree or plant. Leaves grow thin and flat in order that as much surface as possible may be exposed to the sunlight. If a leaf were curled up like a hoop only a part of the outside surface would be exposed to the sunlight and the amount of life that a leaf could supply to the rest of the tree would be much less. The leaf is so constructed that when the sunlight strikes down upon its green surface, it changes the carbonic acid gas which it drinks in, into its elements, i. e., it takes out the carbon which goes into the body of the plant and combining with other foods and water supplied by the roots causes the plant or tree to grow.

HOW LONG AGO DID LITTLE GIRLS PLAY WITH DOLLS?

At least four thousand years ago, for in Egyption tombs which cannot have been opened for four thousand years we find dolls, carefully carved and painted and nicely dressed, lying next to the mummies of their little mistresses. It is said that the oldest piece of sculpture ever dug out of the earth was a carved doll.

WHY DO GIRLS LIKE TO PLAY WITH DOLLS?

Girls like to play with dolls because they come into the world for the purpose of being mothers and the love which they display for their dolls is the mother instinct which begins to show itself early in life. The doll is a make-believe baby to the little girl, but most any little girl will drop her dolls if given an opportunity to play with a real live baby. Once in a while we find a little girl who does not care for dolls but usually if placed with other little girls who have dolls she will soon become just as devoted a little mother as they.

IS IT GOOD FOR US TO LAUGH?

The old saying "Laugh and grow fat" suggests that laughing is good for us, though perhaps getting fat is not the best proof of it. But it is true that we do derive benefit from laughing. Happiness strengthens the beat of the heart and deepens the breathing, and this extra deep breathing and increased heart action insures that more oxygen passes into the blood, and that the blood is carried more quickly to all parts of the body. If food is eaten with pleasure the digestive juices pour into the stomach and we have better digestion than when we are unhappy and worried.

WHY DOES MY HEART BEAT FASTER WHEN I AM RUNNING?

When you run more blood is needed in your legs and other parts of your body. The operator in charge of the exchange sends orders to the heart to beat faster, and the heart obeys. If you stop running the heart will keep on beating fast until the necessity ceases.

WHY DOES THE HEART NOT STOP BEATING WHEN WE ARE ASLEEP?

It is necessary that the heart beat continually and it is just as necessary that the brain have some rest. If some arrangement had not been made so that the heart could beat while the brain rested we could not live. So under ordinary conditions the heart beats are controlled by certain nerve cells which are located in the heart itself. Under certain conditions, though, beats of the heart are controlled directly by the brain. We may look at it this way: The heart is a machine largely automatic in its work, but then the most perfect automatic machine in the world requires an operator to watch it. So the intelligence in charge of the cerebro-spinal exchange in the body has his eye, so to speak, on the heart, and even when the body is asleep there is always a night force as you might say left in charge.

WHY DO MY HANDS TURN BLUE WHEN COLD?

The heart forces through the arteries the pure blood, which is red in color, and after this passes through the capillaries it is returned to the heart through the veins. The veins carry only used-up blood, and this is of a purplish blue color. When your hands get cold it is because there is not sufficient circulation of warm red blood through the arteries to keep them warm or to give them a pinkish color. The veins though are filled with blue blood and as there are many veins close to the surface the hands look blue when they are cold.

WHY DOES MY FACE GET RED WHEN I RUN?

When you run or exercise violently more blood is required in all parts of the body, so the intelligence in charge instructs the heart to beat faster and to force more blood through the arteries. That the heart obeys, you can tell by feeling it after running and noting how much faster it beats. The blood that the heart forces through the arteries is bright red in color and as the walls of the arteries are thin the color shows through and gives the skin a red or pinkish color.

HOW DO BIRDS FIND THEIR WAY?

One of the most interesting things in nature is the migration of the birds. In the fall some go south to a warmer climate and in the spring they come north again. Some birds even come back to the same tree and the same nest. For want of a better explanation we call it the "instinct of migration," but this is really more a statement of fact than a true explanation of their ability. To tell the truth, we do not know just what impels the bird to make these long flights or how they are able to find their way back over hundreds, sometimes thousands of miles of unknown country. Turn back to our spring rambles and read about bird marriages.

WHY DO BIRDS SING?

Birds sing when they are making love. The male bird is the singer and sings to his mate to attract her, to charm her, and to further his wooing. This lasts even after the eggs are laid, and while they are being hatched. But, just as soon as the little birds are hatched the singing ceases, and the father bird devotes himself assiduously to the task of providing meals. He seems to realize that the time of play is over and that the duties of fatherhood are serious ones. But if the nest should be destroyed or the little ones removed, he will start his singing and wooing over again, as if to inspire his mate to help him build another nest. Then again birds sing because they are "built" that way. They sing to express pleasure. The canary in your room certainly sings because he enjoys it.

WHY DOES MY HEART BEAT FASTER WHEN I AM SCARED?

Because the intelligence in charge of the central telephone exchange of the body is suddenly informed that danger threatens and instantly orders every muscle of the body to be ready for action and the heart responds by sending increased blood supplies to all parts of the body.

HOW HIGH UP DOES THE AIR EXTEND?

Just how thick the layer of air which surrounds the earth is we do not exactly know. Near the earth's surface the air is quite dense, but as we go higher and higher it becomes thinner or more rarefied as we say. Thus at the top of some of the highest mountains it is hardly sufficient to breathe and in some of the recent flights in air ships when very high altitudes were reached the aviators carried cans of oxygen with them.

It is probable that the air extends upward some fifty or a hundred miles for we know that shooting stars, or meteors, are not visible until they strike the earth's atmosphere and we see them when they are many miles away.

HOW FAR AWAY IS THE SUN?

It is almost as difficult to give an idea of the distance to the sun as it is to explain its size. When you are told that it is five blocks or five miles to some place you can easily understand what is meant, for you have often gone that distance, but when you are told that it is over ninety million miles to the sun, you really do not know much more about its actual distance than you did before. Perhaps the following illustration will help. About the fastest that man has ever traveled has been in some of the newer aeroplanes and these make a speed of about one hundred fifty miles per hour. Now, imagine a baby starting in one of the best machines and flying continuously with no rest or no stops. When you learn that he would be seventy years old by the time he reached the sun, you can perhaps form a better understanding of its great distance from us.

WHY IS YOUR RIGHT HAND STRONGER THAN YOUR LEFT?

This is true only if you are right-handed. If you are left-handed your left hand will be the stronger. If you are ambidextrous your hands will be equally strong. We get our strength by exercising, that is, using the different parts of our body. If you are right-handed you naturally use your right hand more, and it becomes not only stronger but more capable than your left hand. However, if you should break your right arm and be compelled to keep it in a bandage for a considerable length of time, you would find that you would use your left hand more and it would become stronger.

WHAT IS THE ORIGIN OF "HONEYMOON"?

Among some of the early German tribes there was a practice among the newly married couples of drinking a kind of wine made of honey for a month after marriage. Thus we get the first part of the word honeymoon from the beverage and the latter part from the time it was used as you know our month is equivalent to one moon.

Nowadays the custom of drinking wine made from honey has been dispensed with and the word honeymoon is used to designate the trip whether short or long, that a newly married couple often take away from home.

WHAT CAUSES THE COLORS OF SUNSET?

At sunset the rays of light from the sun that you see strike the earth at an angle and must pass through a greater distance of air before they reach you. The little foreign particles in the atmosphere break up the white rays just as does a prism, and thus we get all of the different beautiful shades of color. For this reason the sunsets are often more beautiful when there are many impurities and much dust in the air. And for just the same reason that you have red in the morning, the principal color at evening is red.

WHY IS THE SKY BLUE?

Sunlight is a white light and you have probably already learned that a ray of white light is made up of rays of light of different colors. These colors are red, orange, yellow, green, blue, indigo and violet. If you separate a ray of sunlight you will always get these colors in this order. Some things absorb certain of these rays and throw off others, and in doing this make all of the various shades of color. The air or sky is filled with countless tiny specks of dust and these catch or absorb part of the rays of sunlight and throw off others, and it is the ones that are absorbed that make the sky blue. Sometimes the sky is a light blue and sometimes a darker blue and this variation is due to the different kind and condition of the tiny specks of dust and the different angle at which the sunlight strikes them.

WHAT MAKES POPCORN POP?

Kernels of pop corn are filled with tightly packed starch grains. Each kernel is divided into a large number of cells, each of which may be likened to a tin box, the walls whereof are sufficiently strong to withstand considerable pressure from within. Upon the application of heat, the moisture present in each little box is converted into steam that finally escapes by a little explosion. To obtain satisfactory "popping," there is required a high degree of heat. This causes the greater part of the cells to explode nearly at the same time, and the grains of corn really turn inside out, and are changed into relatively large pieces of snow-white starch.

If corn be old and dry it will not pop satisfactorily. A few cells near the center of the grain may burst but the general result will be unsatisfactory, there will be too many hard grains for you to bite. At the base of the kernels, where they come off the cob, the cells appear to be driest, and these cells are seldom burst in the popping. Does anything like this happen when you roast chestnuts? When you bake apples?

WHY ARE SOME PEOPLE RIGHT AND SOME LEFT HANDED?

You probably write and make figures with your right hand, and there are many other movements you can do better with that hand than with your left one, though some of your friends may prefer to use the left. If you observe, you notice that the majority of people are right-handed. You wonder why this is so. We must understand that it is not simply a habit we have formed, for people all over the world are the same in this respect, and as far as we can tell from old pictures and paintings they always have been right handed. If we only question nature closely in this and other matters, we are sure to come upon some simple, and on the whole reasonable explanation that helps us to understand if it does not settle everything.

In this case, the explanation is about as follows: Just as we have two eyes, two ears, two hands, etc., we also have two brains, one of each side of the head, each in a general way attending to one side of the body. Of course, they work together, yet it is true that the left brain attends to the right side of the body, while the right brain attends to the left side. There are some things that the left brain naturally does more efficiently than the right brain. All the speech centers—centers that enable us to talk—of the left brain are more developed than those of the right brain. And, so in general, our left brain is somewhat more active through life than our right one. The right one is in some respects reserved for emergency, like duplicate parts of an engine. But the left brain is more active and since it runs the right side of the body, naturally the right hand and arm are more efficient for many purposes.

"WHAT MAKES POP CORN POP?"

WHY DO PEOPLE LAUGH?

You may not know it, but this is a very hard question to answer. You, of course, laugh when you are pleased; but, then, you also laugh when you are tickled. You may laugh at another to show your contempt for him, you may laugh when your heart is full of hateful thoughts, and you know some people laugh much more than others. When you think about all this, you wonder why you laugh at all. You know that there is a very intimate relation between the body and the states of the mind. The general appearance and actions of a person indicate to a considerable extent his mental make up.

All emotions, fear, anger, love, hate, joy, etc., show themselves in bodily appearance and actions. But the glory and honor of man is the possession of reasoning power. Emotion and reason are, to an extent, opposed to each other. We had better put it this way; emotions, like fire, are good servants, we could not well get along without them, but they are bad masters, and if you desire to be a strong intellectual man or woman you must keep your emotions under control, but that does not mean you must repress them all. Now, there must be some reason why man, the only reasonable animal, is also the only one that laughs.

Laughter, as you know, varies from a slight smile, through silent laughter, to boisterous guffaws. Muscles of the face, throat, indeed all over the body are suddenly active. All the numerous emotions that lead to laughter (and joy, happiness, satisfaction, and so on, are only a few) need to be controlled as well as others, and so all these various muscles are set to work; this action uses up a good deal of the energy in the body that was feeding the emotions, cools us off, as it were, and in a way rouses the brain to control. So, you may say that laughter is one of nature's methods of holding the emotions in check and setting the energy going to waste in the emotions at more useful work. You know a person who is very angry is in danger of doing all sorts of foolish things; if something suddenly makes him laugh, the anger is dissipated and he is not going to do any foolish thing. We are sure you understand what has happened.

DO ANIMALS LAUGH?

Have you a dog, or a cat, or a lamb? Did you ever see them laugh? No, but then they do have ways of showing when they are pleased. Whatever it is, it is some kind of emotion, you see it accomplishes the same results. Now we have a polly at our house and it can laugh as naturally as you can. Here is a question—is it really laughing?

HOW DOES A FLY WALK UPSIDE DOWN?

There is a little sucker on the end of each of the fly's feet which makes his foot stick to the ceiling or any other place over which he walks, and he can control such suckers at will. They are made very much like the sucker you have seen with which a boy can pick up a flat stone—a circular piece of rubber or leather with a string in the middle and more or less bell shaped underneath. A boy can pick up a flat stone with this kind of a sucker by pressing the rubber or leather part down flat on the stone and then pulling gently on it by the string. When he does this he simply expels the air which is between the leather part of the sucker and the stone, this creates a vacuum and the pressure of the air on the outside part of the leather enables him to pick it up. Of course the sticking power of each foot is adjusted to the weight of the fly, just as the sticking or lifting power of the boy's sucker is regulated by the weight of the stone or other object he tries to pick up. If the weight of the object is not sufficient to overcome the sticking power which the vacuum creates, the stone cannot be lifted.

OF WHAT USE ARE PAINS AND ACHES?

All pains and aches are helpful in sounding a warning. A headache may be the result of improper sleep and rest and, therefore, warns us to take the needed rest or sleep. A pain in the stomach is only nature's way of telling us that we have been unwise in our eating and drinking. As a matter of fact, short though our lives are, they would probably be still shorter, on the average, if it were not for pains and aches, because without these warnings we would never have sense enough to stop doing the things we should not do if we are to live normally. But then, pain is only useful as a warning, continued pain uses up energy and physicians give remedies to relieve the same.

WHY ARE SOME FLAMES YELLOW AND SOME BLUE?

The color of a flame depends to a large extent on the substance that is burning, as you know from the colored flames in fireworks. The yellow flame from an ordinary gas burner, or a kerosene lamp or candle, is made up of particles of glowing carbon that have not been completely burned. In a gas stove, air is drawn in from below and mixed with the gas before combustion. On account of this extra supply of air, all the particles of carbon are completely burned, and a blue flame results, which gives much less light but more heat.

You probably have noticed a delicately blue flame playing over a hot bed of glowing coal. This is different from the blue gas flame just mentioned. In this case, the air coming up from below through the hot coal does not find enough carbon to unite with its oxygen, and so it takes on a little more when it comes into the air. Now, we are sure you can tell why the center of a gas flame is blue but the rest of it is yellow. Suppose you shake a dusty cloth near a gas fire and see it color up, then explain it.

WHAT ARE WEEDS GOOD FOR?

Boys are apt to think that on account of weeds they have to work in the garden when they want to play ball. But Mother Nature has some good end in view. Many worms and insects that seem useless to us are, after all, necessary to the fertility of our soil and the life of plants and fruits. What is a weed? Let us give you one answer. A weed is a plant out of place or one that we have not sufficiently studied and so are ignorant of its good features. Do you know that wheat and corn and—well, all useful plants—were once weeds? Only when man studied them and found out how valuable they were, and commenced to educate them did they cease being weeds. When we say they educated them, we mean cultivated them, which brings out good qualities in plants as well as those in boys and girls. Do you see the wild daisies in the meadow? They are weeds there; but Mr. Burbank in California has educated them until they are magnificent great flowers. The morning glory in the field is a weed, but trained around your porch, it greets you to a perfumed and decorated room in the morning. The wild potato is an almost poisonous, tuber-growing weed; what would we do without the cultivated plant we have made of it? There is no telling how many jewels in the rough Mother Nature has for us in what are now unsightly weeds.

WHAT ARE THE THORNS ON ROSES AND OTHER PLANTS GOOD FOR?

The thorns of roses and other plants which have thorns originally grew for the purpose of enabling the plants to fasten themselves on to other things, thus helping them to climb and to protect from animals and also boys that wanted to get their fruits. Many plants with thorns are permitted to grow now in places where they can use their thorns for climbing, but many others with thorns are cut down by the gardener to make the plants shapely and to make them produce more flowers and less branches but they keep on growing their thorns just the same. But we have learned of late years that by kind treatment and education we can induce them to give up their thorns. We have told an interesting story about the cactus that gave up its thorn. Better re-read it.

WHERE DO ALL THE LITTLE ROUND STONES COME FROM?

The little round stones you are thinking of are really pebbles which have been worn smooth and round by being rubbed against each other in the water through the action of the waves on a beach, or the running water of brooks and streams. This sort of rock is called a water-formed rock. Some of them have traveled many miles before settling where they are found side by side on the shore or in a large mass of what we would call conglomerate rock. But whenever you see a round smooth rock or pebble you may be sure that it was made round and smooth by the action of water.

WHAT MAKES THESE GROOVES AND SCRATCHES IN THE LITTLE STONES?

You only find stones so grooved and scratched in sections of country once covered by glacial ice. You know ice is only one form of water, but glacial ice moved the great boulders seen on the prairies and in other sections and great quantities of little stones, which it marked as you see. The grooves are a kind of writing left by nature for you to read and it is a most interesting story.

WHAT ARE ANGLE WORMS GOOD FOR?

You are going to say they are good for bait in fishing. But Mother Nature would laugh at you. No, they are the farmer's first assistants. You see there are so many thousands of them in every acre of ground and they are all digging little tunnels, and working the earth over and over that they do a great work in increasing its fertility. We can't get along without them. Mother Nature has some useful work for all her animal forms, though we do not know what it is in all cases. What are snakes good for? or spiders? or flies?

WHY DO A CAT'S EYES SHINE IN THE DARK?

To shine in darkness a body must be luminous, or light giving, and no creatures possess luminous eyes. A cat's eyes appear to shine in the dark because they have very wide-open pupils to catch what light there is, even collecting rays which are not visible to us. By reflecting this light the cat's eyes appear to shine with a light of their own. But do you know anything that does shine in the dark?

WHAT ANIMAL USES A LAMP WHILE FISHING?

Far down in the depths of the ocean where there is always a semi-darkness is found a fish called the "deep sea angler." He goes about with a small luminous knob projecting from the top of his head. This attracts curious small fish, and while they are investigating it, the angler fish makes a quick dash and secures them for his food.

WHAT INSECT CARRIES A LAMP MORE EFFICIENT THAN THE BEST ARTIFICIAL LAMP INVENTED?

Perhaps the greatest problem of the modern lighting engineer is to perfect a lamp that will give the most light with the least heat waste. In a gas jet only about two per cent of the energy is transformed into light and in a good filament electric light not more than eight or ten per cent. The efficiency of the firefly's light is estimated at one hundred, there seeming to be no waste whatever in heat.

WHAT ANIMAL FILLS ITS LEGS WITH WATER WHEN IT WALKS AND FOLDS THEM UP WHEN AT REST?

The starfish has hundreds of tiny hollow legs that it inflates with water when it wishes to walk. It reaches these feet out to some object and with the aid of a sucking disk on each foot pulls its body forward. We have read about an insect with a sucking disk on its foot. What was it?

WHICH IS STRONGER IN PROPORTION TO ITS SIZE, A BIRD OR A MAN?

A bird is said to have proportionally five times as much energy as a man. When we take into consideration the immense distances that birds fly and the speed they attain we can readily believe this. In order to keep up this supply of energy birds must eat a great deal more in proportion to their size than is required by a man. What invention imitates a bird? Do birds chew their food? How does Nature grind it for them.

WHY DOES RAIN MAKE THE AIR FRESH?

There is considerable dust and other impurities in the air. As the rain falls, it catches these impurities and brings them to the earth thus leaving the air washed absolutely clean. During a rain there are usually considerable electrical changes in the atmosphere and these electrical changes produce a gas called ozone which has a delightfully fresh smell.

HOW DO BIRDS LEARN TO FLY?

In most instances birds are entirely helpless when hatched and must be cared for by the father and mother bird until strong enough to look out for themselves. Birds are probably not taught much in the sense in which we ordinarily mean it, as when we say a boy is taught his arithmetic lesson. Practically all of a bird's knowledge comes to it by instinct. Sometimes though, we see an old bird fluttering about in the trees near a young bird as if to instruct it and to encourage it to make an attempt at flying. Valuable knowledge of use of flying machines was gained by watching young storks practicing with their wings.

WHAT INSECT CARRIES ITS BABIES IN A VALISE?

Attached to the body of the cockroach is an egg case which looks considerably like an old-fashioned valise. This is divided into two compartments and there are about thirty eggs in each. When the mother cockroach feels the little ones stirring she rips up the valise, lets out the babies, and then with true economy, eats up the case.

HOW FAST DOES A WIRELESS TELEGRAM GO?

The speed at which a wireless message travels is supposed to be about 186,000 miles a second. Thus if you were in New York and sent a message to London it would take about one-sixtieth of a second for it to cross the Atlantic, a period of time too small for the human mind to grasp. In other words a wireless will cover a distance in a fraction of a second that it takes the fastest ship almost a week to cross. What is it that travels? Sounds? Vibrations? In what do they travel? Air? Ether?

HOW WAS THE FIRST LEAD PENCIL MADE?

It was long known that a piece of graphite would make a mark if rubbed on a piece of paper, but it remained for a school girl in Danvers, Massachusetts, to make the first lead pencil. It is said that she took a piece of graphite, crushed it with a hammer, mixed it with gum, and stuffed the mixture in an alder twig from which the pith had been removed. This experiment was successful and since then many improvements have been devised until now the manufacture of lead pencils is a highly specialized business. Is graphite lead? Here is a strange fact to think over; that girl—being such a smart one—probably got rich and wore diamonds in after life. Do you know that graphite and diamonds are only different forms of the same thing?

WHAT IS GRAPHITE?

Graphite is a form of carbon. Did you never smoke a piece of glass to look at the sun? The black substance that gathers on it is pure carbon. You know that coal is largely carbon, and that the varieties of coal —bituminous or anthracite—were caused by a difference of the pressure to which the coal was subjected when it was forming. So that we have soft coal west of the Alleghanies and further north and east we have graphite. Where the pressure has been very great (say deep in the earth) we have diamonds.

WHAT MAKES THE STARS TWINKLE?

The stars really do not twinkle, but just appear to do so. You probably know that many if not all of the stars are great suns which are constantly throwing off heat and light just as our sun does only they are so far away that but little of either ever reaches us. When the light from a star strikes the air which is around the earth, it encounters many objects—little particles of dust and water which are always floating around in the air. These interfere with the rays of light. If you were to look at a lighted window some distance away while many people were passing, the light in the window would appear to twinkle.

WHEN WAS ASBESTOS FIRST USED?

The early Greeks seem to have used it woven into cloth for aprons and in connection with some of their religious ceremonies because it could be made absolutely clean by the great purifier, fire. Asbestos is a curious paradox because it has the characteristics of both vegetable and mineral matter. It is fibrous like the flax and hemp that grow in the fields; yet it is the one indestructible element on which neither fire, water, acids, nor time have any effect. It is found in the earth in layers between beds of stone. There is no certain means of locating it except by exploring without any definite traces as a guide. It exists all over the world, but the best quality comes from Canada. This is so strong and white that it can be made into stout cloth without the addition of any other substance.

WHERE DO WE GET OUR TIME?

Three and three-quarter minutes before noon on every week day the beats of the Naval Observatory clock at Georgetown Heights, in the city of Washington, begin to sound over a special wire of the Western Union Telegraph Company, which is connected with 900,000 miles of telegraph lines stretching all over this country. Once a second a signal is ticked off, until ten seconds before noon. Then there is an interval of silence, and at twelve precisely a final click tells hundreds of thousands of persons that it is noon by the official Observatory clock in Washington. This clock is set and regulated by star time. The Observatory possesses a telescope so mounted that it points always in the meridian. Every night several observers watch through this telescope for the passage of certain stars across the field of view. Precisely when these stars cross a hair line in this field each observer presses a key that records the time of transit. Knowing exactly when these stars are due to pass over the meridian line of Washington, the astronomers take the average of these many nightly observations and from it regulate the master clock, so that it is always ready to send the correct signal each noon.

Man in Naval Observatory touching the clock which makes the ball on the Navy Department fall and gives the time to all America by Western Union Telegraph. The ball falls at noon each day.

WHY DO I GET OUT OF BREATH WHEN RUNNING?

The purpose of breathing air into the lungs is to purify the blood. We have just learned that more blood is required when running, and that means that there is more blood to be purified. The heart beats faster, and pumps more blood into the pulmonary artery, and that in turn conveys it to the lungs to be purified. Unless you are in good training it is almost impossible for you to supply the lungs with enough air for this purpose, and they keep calling for more air.

WHAT IS THE MILKY WAY?

On looking at the sky on a clear night in summer you can see a luminous circle extending completely across the heavens from north to south. This is popularly called the "Milky Way" because it has some resemblance to a stream of milk. It is produced by myriads of stars not hundreds, or even thousands, but actually millions of stars. They are so far away and there are so many of them that we cannot distinguish each separate star, but with a strong telescope many of them can be seen. When you consider that each one of these stars is a sun like our sun, some smaller, but many larger, you begin to realize the immensity of the Universe.

WHY DO NOT THE STARS SHINE IN THE DAYTIME?

The stars shine in the daytime just the same as they do at night, but during the day the light from the sun is so bright and strong that the light from the stars is lost. If you are fortunate enough sometime to witness a total eclipse of the sun you will be able to see the stars in the daytime, or if you will go down into a deep well or a mine where you can only see a small patch of the sky you will be able to see the stars during the day.

WHY IS GOLD SO PRECIOUS?

Gold has long been considered one of the most precious metals because of its beautiful color, its luster, and because it does not rust or tarnish when exposed to the air. It is the most malleable metal, by which we mean that it can be hammered into very thin sheets, so thin that it would take 200,000 of them to make an inch. It is the most ductile metal, meaning that it can be drawn into the thinnest wire. It is very difficult to dissolve gold, no acid will touch it and only by combining nitric and sulphuric acid can it be dissolved.

WHY DO WE HAVE TO LEARN TO SWIM?

With the exception of man, and possibly the monkey, all animals swim naturally. Of course, some can swim better than others, but with the exception of the two just mentioned all can manage to keep afloat for some little time at least. Man's natural motion is climbing, and this motion is not adapted for swimming. This motion is just as much an instinct in man as swimming is in a duck, and therefore before a man can swim he must learn. How did you learn to swim? What warm blooded animals (not fishes) live in the sea?

OF WHAT USE IS MY HAIR?

Long ago man's entire body was covered with hair, just as some animals are to-day, as a protection against heat and cold. But man has worn clothing so long that the need of hair for protection from the elements has disappeared, and so has hair, excepting on the top of the head and the face. It is believed by many that the time is coming when human beings will have no hair. To-day it is used mainly as an ornament. Are all races of man alike as regards to hair? Read about the Ainos.

WHY DO WE COOK THE THINGS WE EAT?

We have several reasons for doing this. The first and most important reason for us is that the application of heat to food makes it more easy to digest. Other reasons are that when cooked our food is more palatable, the process of cooking kills all microbes, which, if taken into our bodies alive, would give us diseases, and also it is easier for us to chew food that has been cooked. Do you think cooking helps such fruits as strawberries, plums and peaches?

WHY IS A TIGER STRIPED?

Did you ever see a little lizard they call a chameleon? They are harmless little animals that have the strange power of changing their color to make it like their surroundings. If you put one out on the lawn it will soon be green in color; then if you place it in the center of a red carpet it will soon turn red. The explanation is that nature is kind to all forms of life and provides various devices that serve to protect from enemies and also help to secure food. One of these devices is to give them a color like the scenes among which they live, so that they will not be readily noticed. The lion loves the open ground, so its fur has become a mixture between yellow and gray, like the sand and rocks. The tiger hunts in marshes or among long reeds and grass, so its coat is a fawn color with stripes of black, or a color almost black. When it crouches down among the reeds or tall grass, it looks like the ground with shadows of the reeds showing on it. We are sure that you can now tell at least one reason why some of the animals you see in a zoo are colored as they are. Can you tell why the polar bear is white? Do you think it all chance that birds whose home is in tropical forests where flowers are so brilliant have such beautiful plumage? During the World War, we made use of this same principle. How? Read Modern Warfare.

HOW DO YOU SEE YOURSELF IN A GLASS?

We only see an object because rays of light coming from that object strike the eye. Now it makes no difference how bent or crooked that ray may be, if it reaches the eye we will see the object. A mirror, you know, is glass with some mercury amalgam (mercury combined with tin) on the back of it, forming a splendid reflecting surface. That is a surface such as rays of light hitting it bounce, just as a ball bounces when you throw it against a wall or the sidewalk. If you stand directly in front of the looking-glass the rays of light going from you to the glass come back to you just as the ball did, and you see yourself through the reflected rays of light. You must remember that you can see by means of a bent ray of light just as well as if it were straight, for this fact will explain a great many things you will hear about later on. For instance, men in a submarine (a boat down under the water) can see what is transpiring on the surface by means of a periscope, a steel tube with a mirror at the top, so arranged that the rays of light reflected from its surface go straight down a tube to the man at the other end, under the water. Do you think you could arrange mirrors so you could see things on the other side of the house? Be sure and read about submarines in Modern Warfare.

WHY DO WE HAVE TO BREATHE?

When you breathe, the air which is around us on all sides passes into the lungs. You know that a very large part of the air is a gas called oxygen. Now, oxygen is such a friendly gas that it readily unites with a great many other substances; that is to say, it oxidizes them, which is only another way of saying they burn. This burning may be very slow, as in rusting iron or it may be at a rapid rate as in a fire, you also know that we burn rubbish and useless material. Nature has a great deal of rubbish to burn. Every minute that we live, sleeping or waking, many of the countless cells in our body become useless, and nature must get rid of them, replacing them with new material from the food we have eaten. Part of this worn-out material is carried by the little blood cells to the lungs, where it is burned, that is, oxidized, by the air just breathed in; then the blood cells load up with a supply of oxygen and start on their return journey to all parts of the body and the oxygen they carry is used to still further burn the body rubbish. You know your body is warm all the time; a large part of this heat comes from the burning that we have just told you about. What is true of us is true of all forms of life (unless some very low forms are meant). All must some way breathe, that is, get oxygen. Breathing, being absolutely essential to life, is involuntary, that is to say we do not have to think about it; but even more, it is so necessary that nature does not allow you to trifle with it to any extent. Try holding your breath. You can do it for a little while, but pretty soon nature pushes you to one side, so to speak, and you breathe whether you want to or not. Somewhere in this volume we have told you what part of our nervous system attends to breathing. Find it and read it again.

WHAT CAUSES THE WIND'S WHISTLE?

The whistle of the wind is caused very much like the whistle you make with your mouth or the noise made by the steam escaping through the spout of a kettle. You do not hear the wind whistle when you are out in it. You can hear it when you are in the house and the wind is blowing hard. When the wind blows against the house it tries to get in through the crevices, under the cracks of the doors, down the chimneys, wherever it finds an opening. And whenever it starts through an opening that is too small for it, it makes a noise like the steam coming out of the spout of the kettle, provided the opening is of a certain shape. Did you never hear the telegraph wires sing? Has the wind anything to do with that effect?

WHY DO MY MUSCLES GET SORE WHEN I PLAY BALL IN THE SPRING?

They do this because you have probably not been exercising the particular muscles which you employ in throwing a ball enough during the winter to keep you in good condition. Muscles which have been developed through use or work need more work to keep them in condition. In a sense certain of the muscles which you employ in playing ball have been treated during the winter very much as if you had tied them down. You have not been using them—they have not been doing enough work, and they begin to lose their strength when for any period they have not been used enough. The soreness that you feel is the natural condition that arises when you begin to use a muscle that has been idle for sometime. There is a lesson for us in this. Don't you know all your mental faculties may be considered as mental muscles? You have been exercising them in school. After school and through life, if you wish to keep mentally alert you must keep up study reading and reflection.

DOES A WORM BREATHE UNDER GROUND?

Every living thing breathes, whether in earth, on the earth, in the sky, or in the water. If it cannot get air, it dies. The worm really has no trouble at all, for there is plenty of air, and to spare, in the earth, anywhere near the surface. Of course, if you dig deeply into the earth, there will not be enough air for a thing like a worm, which needs a good deal; and you will find only living creatures, like some microbes, or tiny plants that need very little air. Further down still, you will find no living things at all.

HOW DO LITTLE CHICKENS BREATHE BEFORE THEY ARE HATCHED?

As soon as life has started in the egg, the little growing chicken or bird of any kind needs air. There is a very small quantity of air in the egg to start with, for you know in every egg there is an air chamber. But that would not last very long. There is, however, no lack of air. Nature has made the shell porous, which means that air can pass through it, and thus the little chick lives until it is big enough and strong enough to break the shell. Thus you see that one way or another nature provides air for her myriad forms of life. Since air is so necessary you must be sure and get your share of it, by keeping your living and sleeping rooms ventilated.

HOW DO FISHES BREATHE UNDER WATER?

If all forms of life must have air, you want to know how fishes can get it under water. Well, in the first place, most water contains a good deal of air that in one way or another has become mixed with it. We learned that air will soak up water; now we learn that water in its turn will soak in air. So the air is in the water for the fishes; the question is, How do they get it? If Nature were to fit them out with lungs, they would have to take in lots of water and the next instant throw it out again. That would make a great deal of unnecessary work, and Nature always dispenses with such work.

To accomplish her purpose, she provides fishes with curious organs called gills. You have seen these openings on the sides of the fish's neck. The water is simply taken in at the mouth and only a little way further on passes out by the gills, but before doing so it passes through the rows of little filaments where the air comes in contact with the blood that has been sent to these minute filaments, just as it does with the very small cells in the lungs. This shows you in what wonderful ways Nature adapts means to ends. Three-fourths of the earth's surface is water which ought to be utilized as an abode for life. We have now learned the principal means Nature takes to accomplish that purpose. Do you now see one reason for giving goldfish fresh water? Do you know any animal that breathes by gills when it is young but by lungs when full grown?

DO PLANTS BREATHE?

Yes, plants form no exception to the general law that all living things require oxygen, which is derived directly or indirectly from the air; and Nature has provided plants, not less than animals, with special organs wherewith to obtain oxygen from the air. To animals that live in the air, she gives lungs entirely within the body; to animals that live in the water she gives gills which are modified lungs moved up to the neck. In the case of plants, the leaves serve for lungs, mouth and stomach. Though we must understand that leaves are only the principal, not the sole, organs that serve these various purposes, other parts of a tree can also absorb air, take in nourishment, and prepare it for plant growth. But the leaves are the real lungs of the trees.

WHAT IS THE MOST BEAUTIFUL SEASON OF THE YEAR?

Each season has a charm of its own. In a way the year symbolizes human life. Winter is infancy, when we can do nothing simply gathering strength for future use. Spring is boyhood when our capacities—like the flowers of spring—are just beginning to develop, when we are preparing for our summer time, when the years of preparation in our youth are bearing fruit. Then comes the autumn of our life. When the years of effort with results,—successful or otherwise—are behind, we are looking forward to a change more mysterious than birth. It should be a time of calm enjoyment. We will now answer your question by asking one which season of life should be the most beautiful?

HOW DO LEAVES ENABLE A PLANT TO BREATHE?

When we ask how leaves enable a tree to breathe, we learn they are very wonderful structures and illustrate once more the marvelous means nature employs to accomplish her purposes. On the sides of a leaf are many thousands of minute openings called pores, which, like the cells in the lungs, or the filaments in the gills, bring the oxygen of the air in contact with the sap (which is the blood of the tree), where it acts just as it does in the case of animals, burning up some rubbish and being carried off to the other parts of the tree by the sap cells.

This breathing goes on day and night as long as the leaves are active, but you know the leaves fall off of most trees in the fall and the tree as a whole takes a good long rest during the winter. To show you how necessary breathing is to plants, if you would put a little bush under an air-tight glass covering, it would, of course, get light and heat, but as it cannot get fresh air, it would die, just as surely as you would if shut up where no fresh air could reach you.

WHY DOES A CAT HAVE WHISKERS?

Because a cat can go about so safely and rapidly in the dark without injury to himself or without running into things, nearly everyone believes it is due to the fact that he sees quite well in the dark. That a cat can see, to a certain extent, in the dark is quite true, but it is doubtful if he could go about as rapidly in total darkness as he does in daytime if it were not for his long whiskers. Take a look at a cat's whiskers and you will see they are always as long as, generally longer than, his head is wide, and a cat's head is as wide as his body. These delicate hairs are wonderful mechanisms. Each one grows from a follicle, or gland, nerved to the utmost sensibility. Its slightest contact with any obstacle is instantly felt by the animal, though the hair itself may be tough and insensible. The next time you go to a zoo or a park where they keep wild animals, take a good look at the lions and tigers and you will see they have similar whiskers. This is because they are all cats, sort of big brothers and sisters to the ones you play with. Does a rat or a mouse have similar whiskers? Do you think the feelers on ants and other insects are anything of a similar nature?

WHY IS A DOG'S NOSE ALWAYS COLD?

We know you like your dog, but you cannot help a little shiver when he pokes his cold nose in your hands, and you wonder why, when his body is so warm, that this one spot should be different from all the rest of him. Let us first tell you an interesting old story about it. When Noah tried to get

THE FOREST RESPLENDENT WITH AUTUMN TINTS.

the animals into the ark some of them were troublesome and he had to have a dog help him. Because of this the dog was the last animal to get in and the ark was then so full that the poor dog had to stand in the doorway with his nose outside, in the wet, and it has never been warm since. Science, however, gives an explanation which shows us there is always some good reason in explanation of unusual things about animals, plants or our bodies. The coldness of a dog's nose is, it says, due to the fact that it must be kept moist all the time in order to sharpen his sense of smell. And, of course, as the moisture evaporates, it keeps his nose cold. How about your own nose, is it not generally cool, more so than your cheek?

HOW IS THE NOSE KEPT MOIST?

Do you remember your question, where tears went to? Well, we found they fed through a little canal into the nose, and so of course, as there is constantly a supply of tears washing the eyeballs and then feeding into the nose it is kept moist. Notice how simple, yet efficient are all of nature's works. You have now discovered three ends served by tears. 1. They remove poisonous, depressing secretion for the body that we secreted when sad. 2. They wash the eyeballs thus removing dust and irritating particles. 3. They serve to keep the nose moist, a necessary provision to enable the nose to act as a smeller.

WHY ARE LEAVES ON TREES AND BUSHES GREEN?

We have told you how leaves act as lungs. Now, we will tell you how they act as stomach, or, in other words, how plants feed. You should understand, though, that a great ‾al of plant food comes from the ground, by way of the roots. The most important material of all, however, and the one most abundant, which builds up the body of the tree and constitutes the wood which burns readily is carbon, that comes from the air by way of the leaves. A leaf looks thin, but it is really a very complicated thing. Between its two surfaces is a thin layer of cellular tissue; so called because it contains a great many little cells. These cells are full of very small grains that contain a chemical substance called chlorophyll. It is this green matter that gives color to the leaves. Chlorophyll has the strange power, when acted on by light, of decomposing or splitting apart carbonic acid gas that is always mixed with the air. So, when air enters the breathing pores of the leaf that we have told you about, the cells strain out, so to speak, that gas and split it apart, giving the carbon to the sap, which carries it away to build up the tree. In this way, also, is derived some of the oxygen that plants need though the most of that is gained by the lung function or work of the leaf. We must add however, that these cells can only split up the gas and feed the tree or plant when acted upon by light; consequently, they cannot do this work at night, and trees and other plants then go to sleep, like most animals. Trees, of course, take a long rest when the leaves are off in winter. Now, can you tell why in a country like Alaska vegetation grows more rapidly during the short summer than, say, in the central part of the United States?

WHAT IS THE MOST USEFULLY VALUABLE METAL?

If you were guessing you would naturally say that gold is, of course, the most valuable of the metals. But you would be wrong.

The proper answer to this is iron. We do not mean the pound for pound value, for you could get much more money for a pound of gold than for a pound of iron, but we mean in useful value—iron is in that sense the most valuable metal known to man. This is so because iron is of great service to man in so many different ways, and it is very well that there is so great a quantity of it for man's use.

WHY DO WE USE SOAP TO WASH OUR HANDS?

Well, in the first place, there is always a little oil on the cuticle of our hands, which is nature's way of keeping it in good condition; but the oil gathers minute specks of dirt from things we handle. Thus our hands become dirty, though we may think we have handled only clean things. Now remember, the dirt of our hands is mixed with the oil always present. A collection of tiny drops of oil held in some other fluid is called an emulsion. Water alone will not form an emulsion with oil, because the two will not mix, so we cannot wash well with water alone. But when water has soap dissolved in it, it is able to make an emulsion with the oil on our hands or anything we are washing, and as an emulsion, the oil and dirt is readily washed from our hand. Does this help you to understand why oiling your shoes tends to keep your feet dry?

WHY DO WE COUNT IN TENS?

When man even in his uncivilized state found it necessary to count, the only implement at hand was his fingers and toes, and as he had ten fingers and ten toes, he naturally began counting in tens, and has been doing so ever since. When we today count on our fingers we confine ourselves to our fingers leaving our toes in our shoes, where they naturally belong. But the first man who counted used both fingers and toes and so he was able to count twenty before he had to begin over again, while little children today, when they count with their fingers, must begin where they started after they reach ten.

WHY DOES A CRUST GENERALLY FORM IN A TEA KETTLE THAT HAS BEEN USED FOR SOME TIME?

Did you ever boil maple sap to make sugar? You know the sugar is left behind as the water in the sap boils away. It is the same with hard water in a tea kettle. The water part is sent away as steam, the impurities remain and deposit themselves as a chalky crust, mostly lime, for that is the most common impurity. Now you see why railroads are anxious to get as pure water as possible to use in the boilers of their locomotives, also why boilers in big factory engines occasionally have to be cleaned. Did you ever read of thick layers of salt in the ground? Does this explanation help you to understand how they got there?

WHAT MAKES A ROCKET RISE?

It is the same force that sends a bullet on its way, but in this case it is differently applied. Did you ever fire a gun? If so, it may have kicked you. Sometimes it kicks pretty hard. Well, in the rocket it is one continuous kick from the time the fuse is fired. You know how the rocket is made—the long lithe shaft to keep it steady in its flight, the tube at one end. You know there is powder in the tube; the tube itself is too strong for the powder to burst, but when the fuse is fired great quantities of gas form. The tube cannot contain all the gas, and as it forces itself out with a rush, the air immediately in front does not get out of the way fast enough, so the entire rocket, tube, shaft and all, is just pushed away to make room for the escaping gas and as it is pointed up away it goes with a loud swish. You know it will fly in any direction in which it is pointed. Do you believe you could make a long arrow, perhaps sharpened at one end, and instead of using a bow, arrange it in a tube, something like a gun barrel only longer, put a tube in it like a rocket and shoot it? Does this answer help you to understand why a pin wheel turns round and round? Did you ever have any snakes in the grass on the Fourth? What makes them run around? One more question for you to help answer why is the end of the tube pointed?

HOW LONG A TIME IS "QUICK AS A WINK"?

You know it is a very short time because if you wish you can wink very fast. The time required in making the different movements of a wink has been measured, and it is found that the average time for the descent of the lid is from seventy-five to ninety-one thousandths of a second. The interval while the eye is shut was in one case only fifteen hundredths of a second. The raising of the lid occupied seventeen hundredths of a second. A specially arranged photographic apparatus was used. So the popular saying that something is done "quicker than a wink" means a time that may be stated in fractions of a second.

WHAT MAKES A COLD GLASS CRACK IF WE PUT HOT WATER INTO IT?

Hot water will not always cause a cold glass to crack, but is very apt to, especially a thick glass. The very thin glasses will not crack. The test tubes used by chemists are made of very thin glass, and will not crack when hot liquids are poured into them. When a glass cracks after you have poured a hot liquid into it, it does so because, as soon as the hot liquid is put in, the particles of glass which form the inside of the glass become heated and expand. They begin to do this before the particles which form the outer part of the glass become heated, and in their efforts to expand the inside particles of glass literally break away from the particles of the glass which form the outside, causing the crack. The same thing happens if you put cold water into a hot glass, excepting in this instance the inside particles of the glass contract before the particles of the outside of the glass have had time to become cool and do likewise.

WHY DO WE TAN WHEN EXPOSED TO THE SUN?

As soon as we expose our bodies to the sunlight the skin becomes tanned, that of brunettes taking on a bronze color, that of blond persons becoming dark yellow. What has happened? In order that the scorching rays may not penetrate the delicate tissues under the skin and injure them, nature begins at once to pack the pigment cells that are thickly placed in the inner layers of the skin with colored substances to keep back rays of the sun that act on the tissues. From all parts, flow coloring matters; first, the yellow pigment from the fat cells; then black pigment formed from the blood by a gland in the kidneys called suprarenal. These glands have a great influence on our health, and when they are excited to supply coloring matter that influence is intensified and they invigorate the system. This probably explains why sun baths are so powerful a tonic; but if this be true, notice this curious result—a sun bath is beneficial, not directly but because an important gland in the body gets to work in earnest to overcome the irritating action of sunlight.

WHY DOES THE SOUND STOP WHEN WE TOUCH A GONG THAT HAS BEEN SOUNDED?

When we touch the gong we stop the sound waves which the gong gives off when it is struck. These sound waves continue after the gong has been struck in continuous vibrations until something stops them. When you touch a vibrating gong, you stop its vibration. If you only touch your finger to the vibrating gong you can feel the vibrations which cause a little tickling sensation. Naturally when you stop these vibrations you stop the air waves which the vibrations cause, and thus also the sound of these air waves striking your ear are stopped and the sound ceases.

WHY CAN WE MAKE SOUNDS WITH OUR THROATS?

In our throats are two cords that we call our vocal cords. When we talk we cause these cords to vibrate and thus we make the sounds of our voices. The most wonderful part of this voice of ours is that with only two vocal cords or wires, we can produce practically all the notes that can be made with a piano, which has a wire or cord for every note, excepting that we cannot make so many at one time. The human throat is so wonderfully constructed that we can lengthen or shorten our vocal cords at will and produce, with two strings, in our throats as many notes as it takes the piano many more strings to produce.

WHAT PUTS SALT IN THE SEAS?

The rivers all, sooner or later, pour their water into the sea, and carry with them vast quantities of solid matter and matter in solution. You know that water dissolves sugar if you put some in it. There are other things that water will dissolve and salt is one, consequently the rivers are carrying away salt all the time; because salt is very common in soil. It is, however, in such a small amount in the river that you do not notice it. The waters of the seas are evaporated by the sun, but none of the salt is taken up into the clouds. The water, then, that returns to the earth has no salt; but by the time it reaches the sea again, after soaking through the soil and flowing down the rivers, it has another load. Consequently, the oceans are receiving salt all the time, but never giving up any of it, and so the ocean water must get more and more salty as time passes. Do you know of any small bodies of water that have no outlet and so have become very salty, in fact almost brine? Do you know of such a body of water in the United States? Why does Lake Michigan remain fresh?

WHY DO WE HAVE LINES ON OUR HANDS?

It is claimed by many that the use of these lines is to help the sense of touch in our hands and fingers. By making little valleys and ridges the lines increase the surface of the skin, and by going in different directions help us to feel the kind of surface peculiar to an object that we touch. The little endings of the nerves of touch are placed to the greatest advantage by means of these lines. That seems to be the reason why they are so very well marked on just those parts of the skin where delicacy of touch is important. Perhaps you know that some people think they can tell your past life from these lines, and also tell you what your future is to be. It is true that the lines on no two hands are just the same, but all you can possibly decide from that is that they probably have something to do with the sense of touch, and people differ among themselves in that respect, which difference may possibly show in the lines. Look at the lines in your own hands, compare with other hands. Do you think that the lines on a blind man's hand, in general, are apt to be more prominent than those in the hands of people that can see?

WHERE IS THE WIND WHEN IT IS NOT BLOWING?

The answer is, of course, that there isn't any wind then. To understand this perfectly we must study a little and find out what wind is. In plain words it is nothing more than moving air. If you make a hole in the bottom of a pail of water the water will run out slowly. If you knock the whole bottom out of the pail filled with water, the water will rush out before you know it. That is about what happens to make the wind. The air is constantly full of air currents, like the currents you can see in a river. Down the middle of the river you may notice a softly flowing current going straight. Along the shores there will be little side currents going in all directions, and you may find some little whirlpools. That is exactly what we should see in the air if we could see air currents.

HOW ARE CRIMINALS CAUGHT BY THE LINES ON THEIR HANDS?

You have heard, perhaps, that nowadays burglars wear gloves in order to avoid leaving their finger-marks on a window-pane or anywhere else. The fact is that all men and women differ from each other in little things, and there is nothing in which they differ more certainly than the patterns of the little ridges on their fingers. Two patterns exactly the same from two different people have never yet been found. These patterns cannot change, for they are formed by the innumerable mouths of the tiny canals which convey the sweat from the deep-seated sweat glands to the surface. They can be destroyed, of course, but no different pattern can be put in their place. Thus, of all the ways of knowing who is who, this is the most certain, as well as much the simplest and cheapest. It is now being more and more used. If a man's thumb-mark is the same as the mark on a piece of paper where a theft was committed, the evidence against him is very strong. A bad man who has become known to the police may change his clothes and the appearance of his face, he may look like a different person, and have not the slightest resemblance to the photograph taken of him. but his thumb-mark will tell him at once. This is now known as the Bertillon System.

WHAT MAKES IT RAIN?

Did you ever take a sponge and let it soak up water? Of course you have, and you have used that sponge to wash your slate and for other purposes, and you know that even when it feels almost dry, if you squeeze it, some water will come out. Pressure does this because it forces the particles of the sponge together, and there is not room for the water. The air is something like a sponge and it generally contains a good deal of water. If we could only imagine something squeezing miles and miles of the air, the water would be forced out just as it is from the sponge when it is pressed. Perhaps you know that when anything loses heat, its particles tend to come closer together. This is true of air as of everything else. So. if warm winds have come in from off the ocean, or lakes, where they have soaked up a good deal of water, and if for any reason they lose their heat, say they come in contact with high mountains or colder air, the loss of heat acts just the same as pressure, perhaps extending over thousands of miles of surface, and the particles of air draw closer together and the water has to fall as rain, or perhaps snow. Look at your geography. If the Rocky Mountains, instead of being where they are, extended north and south from eastern Montana to Texas, do you think there would be more rain in Utah and Nevada?

WHAT MAKES THE DEW?

We must recall what we had to say about the air acting like a sponge and soaking up water, but giving it out again whenever, from any cause, it lost its heat; and in talking about clouds we spoke about the fine mist forming when the air began to lose its heat. Dew can be explained in the same way. When the sun sets the air begins to lose heat, because there is no sunlight sent back into it from the surface of the earth, and so, of course, it tends to lose some of the water that it contains. At such times, the wonderfully small drops of water tend to gather on the points of blades of grass, leaves, growing grain, or other forms of vegetation, and we say "the dew is falling." Perhaps, to make this clear, we should tell you that vegetation, growing grass, grain, etc., ending in points radiate or lose heat more rapidly than the level surface, and so the dew condenses, or gathers as drops of water, on these points. You now understand that dew is tiny globules of water squeezed out of the air that instead of rising and floating away as clouds, settles gently back to the earth. Do you now see why on windy nights the dew does not form?

WHY FLOWERS SMELL SWEETER AFTER RAIN.

Where there is any vegetation rain has a great influence in making the air smell fresher, for water has a special power upon the activity of many kinds of vegetable life that produce pleasant scents. We say that the rain brings out the fragrance of the flowers, and that is true. All life requires water, and all the processes of living creatures are helped by a good supply of water. When rain falls on flowers, and on many kinds of leaves, it sets going the chemical changes which result in the production of many pleasant odors which are added to the air and so help to make it smell "fresh."

WHY DO ANIMALS IN SNOWY COUNTRIES WEAR WHITE COATS.

The use of the white coat is to protect the animal from its enemies by making it difficult to see. If the animal keeps still it can scarcely be seen at all when its coat is the same color as the snow. But if it had a white coat in summer, when the snow goes, it would be easily seen, and so often its coat changes in summer, and the fur takes other tints, more like the color of the ground and the plants among which it lives. This is called protective coloring, and is very useful to many animals. But sometimes it happent that an animal which lives by catching others is also white in winter snow, so that it can get near its prey without being seen. Some insects do the same thing, and when they sit quietly among the leaves of certain plants no one can tell which is insect and which is leaf, so the birds cannot find them.

When you turn to read Modern Warfare, you will see how men make use of this same principle.

WHAT MAKES A RAINBOW?

You know what glass prisms are and you have doubtless played with them and noticed the different colored bands of light seen near them when the sunlight falls on them. The explanation is that a beam of sunlight is not a simple thing, like a straight piece of paper, but it is a cord, so to speak, formed of many different colored waves (or we had better say waves that cause different colors) bound together, as a cord is composed of many twisted threads. This gives you the idea that we want you to form, but, of course, nothing is actually twisted in the sunbeam. Now a prism has the power of separating these different waves (something like untwisting the cord) and spreading them out so that we see the different colors which they make, as violet, yellow, or red bands of light.

Little drops of rain have the same power; so if the sun be shining while the rain is falling, and we happen to be in just the right place, we can see the bow of beautiful colors against the background of sky or cloud. The sun beams striking the drops of falling water have been split apart, bent and sent back to us, and the combined effect of all these little drops is the beautifully colored rainbow. Did you ever see a rainbow at night? Where did the light come from that made it?

CAN A FISH HEAR?

Although fishes are like some other animals in having no visible signs of ears, yet they have them and they serve to conduct sound to the brain. Their organ of hearing consists simply of an internal ear placed inside a gristly capsule. In some fishes, as, for instance, the dog-fish—there is a fold known as the false gill, which is no doubt the remains of a real gill, but is now used for transmitting sounds to the internal ear. In the wall of the capsule which contains the internal ear there is a thin spot, and it is through this thin part, corresponding with what we call the drum of our own ear, that the sound is conducted. Thus, we see that in the case of some of the fishes there has been a change of function of an organ which was in the first place a gill, but has now become part of the hearing apparatus. In other words, it is a structure at one time used for breathing, but now used for hearing.

WHERE DO WE GET THE EXPRESSION "KICK THE BUCKET"?

Unlike the origin of many or most of our expressions this one seems to have had from the first the same meaning as it has today. The tradition is that a certain man named Balsover became tired of existence and resolved to leave this mundane sphere. To accomplish this he stood on a bucket while arranging to hang himself and tied a rope around his neck and around a beam that he could not reach without the aid of the pail. When all was ready he kicked the bucket out from under his feet; and so succeeded in carrying out his own wishes and originated an expression which still means to die.

WHAT IS THE CAUSE OF DIMPLES?

Just under the skin in the tissues are many little fibers which help to hold the skin firm. Some of these fibers are long and some short, and they run in all directions. It sometimes happens that they grow short

WHAT MAKES THE RAINBOW?

in one spot and pull the skin in, making a little depression, and producing a pleasing effect. This may be intensified when one laughs. Some attempt has been made to produce dimples by surgical operations, but without much success.

WHY ARE WE ABLE TO SEE THROUGH SOME THINGS BUT NOT OTHERS?

Transparency is produced by the way rays of light go through substances or not. When light strikes a substance that is almost perfectly transparent, it means that the rays of light go through it almost exactly as they come in. We think quickly of glass when we think of something readily transparent. Water is almost equally as transparent. When the sunlight is shining on one side of a pane of ordinary window glass, it causes everything on that side of the window to reflect the light which strikes it in all directions. When these rays of light strike the window pane, they go right through and that is how we are able to see the trees and grass and everything else through a clear window. The same reason applies also to the water.

HOW DID THE DOCTOR TAKE A PICTURE OF THE BULLET BABY SWALLOWED?

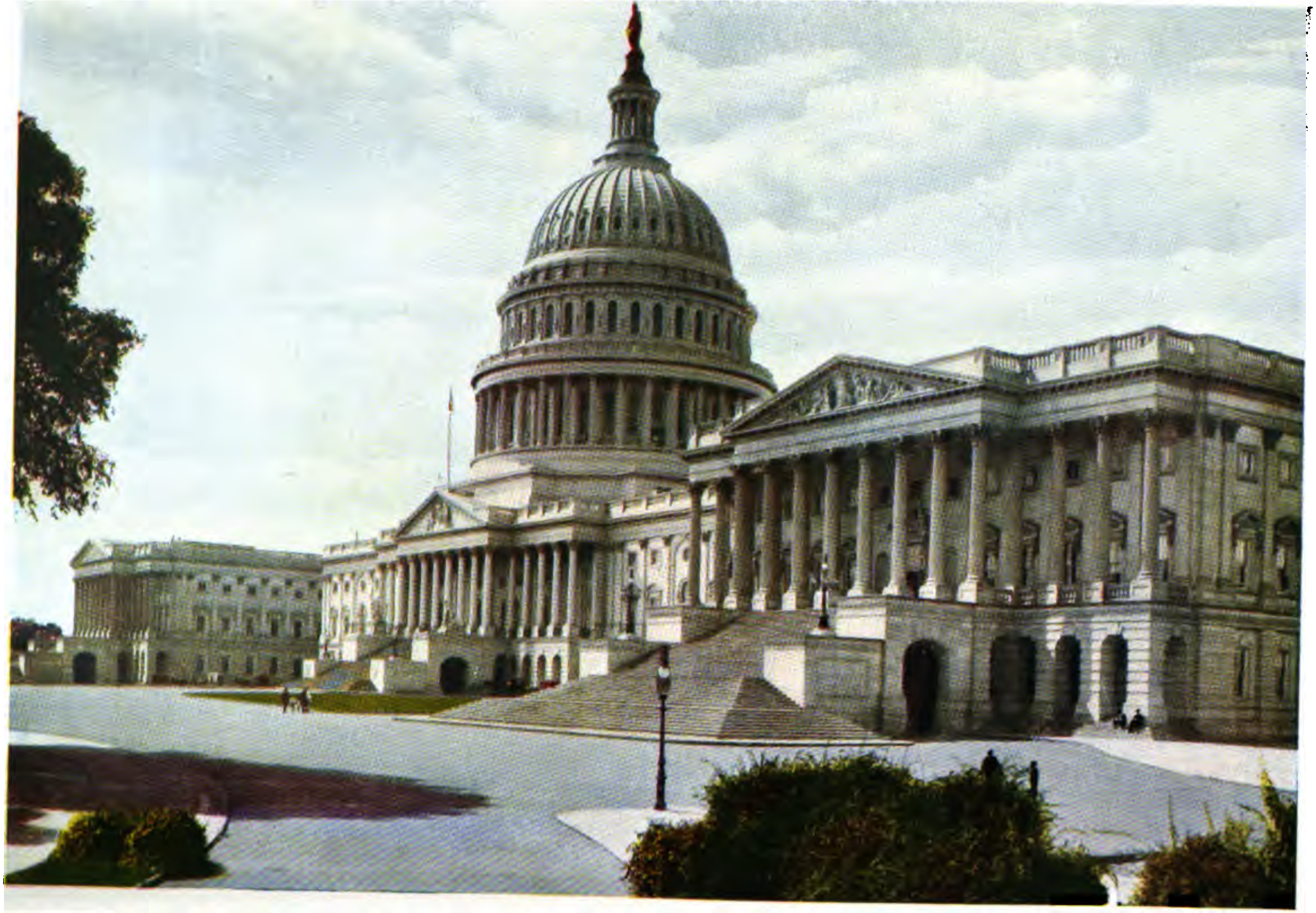
He used an X-ray machine. You must turn back and read about such a machine in electricity. You see, X-rays are a kind of light waves. They go through clothing and flesh of the body as easily as the waves of light we use go through glass. Our eyes can not follow them but the artificial eye of the camera can and it takes a picture of the swallowed bullet as readily as if nothing but glass covered it.

DO ANIMALS TALK?

Well not the way we do, for man has developed language, different classes of words, arranged them in sentences and so on. But Mother Nature provides animals with what we call instinctive calls and notes that certainly convey information from one to the other. Just let the old rooster see a hawk flying high up in the air and give his warning k-r-r-r-k; the hens and chickens in the yard do not hesitate or question a single minute. For each one hurries as fast as it can to some place of shelter. So of all other animals, each one knows perfectly well what their various calls mean. Notice the dog asleep on the porch. He is having a nice little nap, but suddenly he hears the excited yelp of another dog near; he is off like a flash. That peculiar bark has told him something. The next time you go to the zoo, take a look at the babboons. In their wild state, they travel around in droves, and keep up a constant chatter, unless they have some reason for keeping still. It sounds exactly as if they were talking to each other. Are you sure they are not? Scholars have tried to catch on a phonograph cylinder the chatter of monkeys and then study the records to see if they could make out words. One man thought he knew a number of their words, but if so, monkeys are certainly bashful when spoken to in their language, since they refused to talk back to him. Just one question more. We have a Polly. It is said to be a good talker. Does it really talk?

WHAT MAKES ICE FLOAT?

You know the direct answer to this question at once, because it is lighter than water. The real question you want to ask is how comes it that ice is lighter, or less dense than water, when cold contracts, solidifies and this action generally speaking makes a substance more dense? This brings us to a very strange property of water and one most fortunate for human welfare, seemingly in accordance with a general design on the part of nature to accomplish wise ends. Cooling water does indeed contract, though very slowly, until near the freezing point, then it expands, also at a very slow rate, until the freezing point is reached; but in the act of freezing, it expands a little so that ice is not quite as dense as water consequently it floats.



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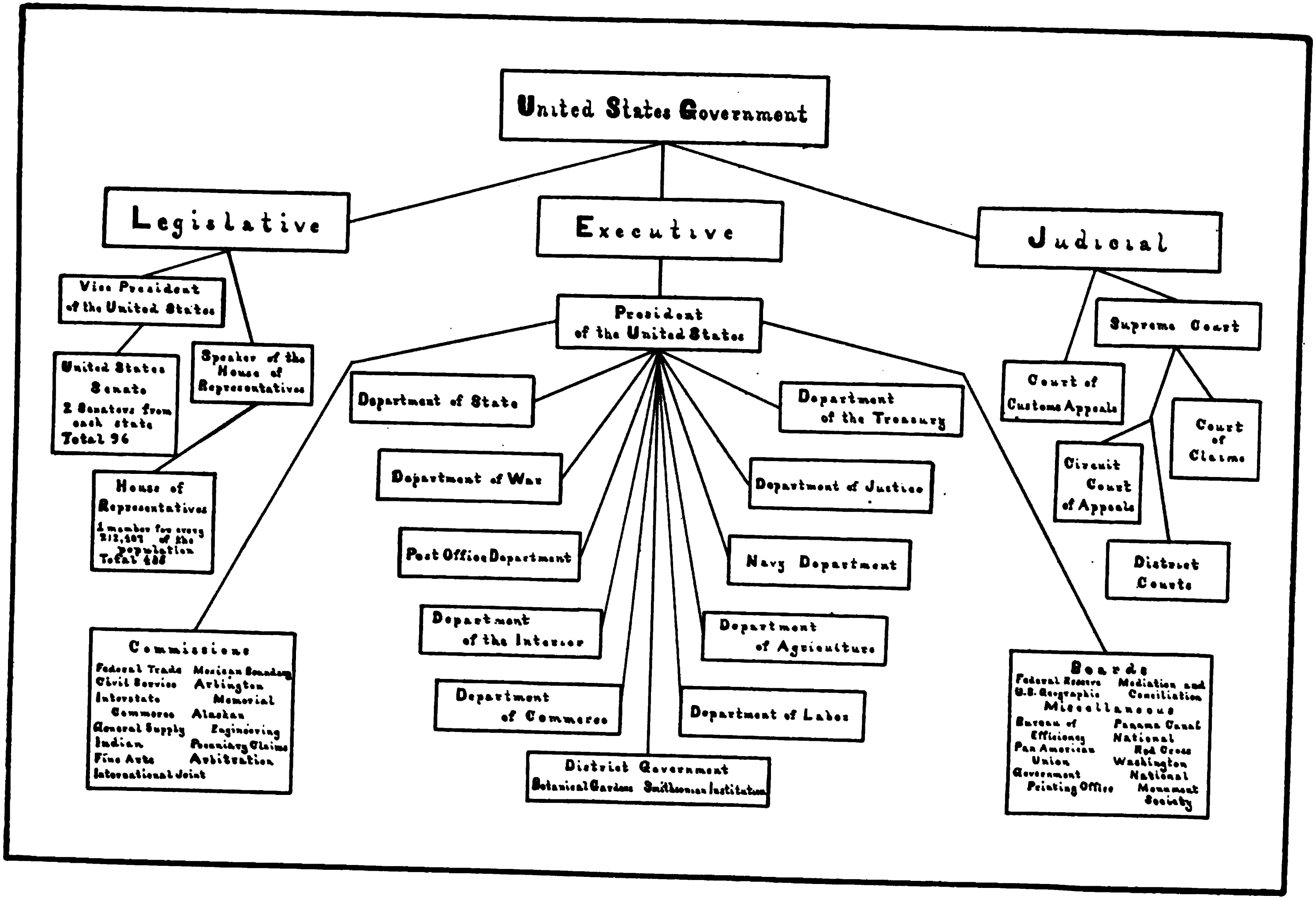
OUR NATIONAL CAPITOL

No Capitol Building in the world is more imposing in appearance. It covers 3½ acres, and is surrounded by a beautiful park and lawn of 50 acres.

BOOK VII

OUR GOVERNMENT

A Careful Analysis of the Government With a Graphic of Each
Department Affording a Clear Understanding of the
Government Under Which We Live. Knowledge
Necessary for All Leaders Among Men


United States Government
Legislative
Executive
Judicial
Vice President of the United States
United States Senate
2 Senators from each state
Total 96
Speaker of the House of Representatives
House of Representatives
1 member for every 212,407 of the population
Total 435
Commissions
Federal Trade
Civil Service
Interstate Commerce
General Supply
Indian
Fine Arts
International Joint
Mexican Boundary
Arlington Memorial
Alaskan Engineering
Pecuniary Claims
Arbitration
President of the United States
Department of State
Department of War
Post Office Department
Department of the Interior
Department of Commerce
District Government
Botanical Gardens Smithsonian Institution
Department of the Treasury
Department of Justice
Navy Department
Department of Agriculture
Department of Labor
Boards
Federal Reserve
U.S. Geographic
Mediation and Conciliation
Miscellaneous
Bureau of Efficiency
Pan American Union
Government Printing Office
Panama Canal
National Red Cross
Washington National Monument Society
Supreme Court
Court of Customs Appeals
Court of Claims
Circuit Court of Appeals
District Courts

OUR GOVERNMENT

We are justly proud of our country, of her wealth and power, her vast area, and her high standing among the nations of the world, and we glory in our free institutions. It is necessary then, that we endeavor to understand what those institutions are. Knowledge of this nature has always formed an important part of a liberal education. It will increase in importance with every passing year. We are living in a new age and victory in the race will be for those fully informed on live topics of the day. We should not only pride ourselves on possessing a fund of general information concerning the government under which we live, but our success in life may depend upon such knowledge. One can scarcely conceive of a successful man or woman, one whom we delight to honor, who is not fully informed along this line.

THE UNITED STATES CONSTITUTION.

The United States Constitution, the highest law of the land, is a written instrument, the result of the labors of a constitutional convention consisting of delegates from twelve of the original thirteen states, meeting in Philadelphia, May 5th, 1787. Rhode Island did not send delegates. The announced purpose of the convention was to amend the old Articles of Confederation. But it was soon apparent that it was necessary to supersede the Articles of Confederation by a constitution, establishing a national government with a "supreme legislative, executive and judiciary." Three states,—New York, New Jersey and Delaware—were not in favor of this departure from the purpose of the original call; but in accordance with the votes of the other nine states, the convention proceeded to draw up a constitution that provides for our present form of government.

DIFFICULTIES OVERCOME.

It is not easy for us to appreciate the obstacles necessary to overcome in order to accomplish this work. There was no precedent to guide our statesmen; each state that met in the convention was a separate independent nation. No national consciousness of unity had been developed. At present, we feel that we are citizens of the United States; it makes no great difference whether the particular state in which we live is one of the New England, or a Southern, or a Western state; but at that date it was different. A man from Massachusetts was a citizen of Massachusetts; he was not vitally concerned in the well-being of the Carolinas. New York was on the point of complete separation from the other states. She had the principal harbor, a fertile territory, and central location, so why concern herself with the other nations? She was about to institute custom houses and exact duties from the trade of New England and the South that sought her marts. And so each state—from Rhode Island with her thousand mile area, to Virginia claiming jurisdiction over most of the Ohio Valley—had its separate ideals, national aspirations and policies. The difficulties confronting the world statesmen in instituting a League of Nations are not greatly different from those that confronted the convention of 1787. Washington was so keenly aware of the difficult task facing the convention that he wrote to a friend expressing his conviction that they would fail to agree and concluded, "I do therefore regret that I have had any agency in the business."

MAKING THE CONSTITUTION.

Among the framers of the constitution were some of the most eminent statesmen of the day,—George Washington, James Madison, Alexander Hamilton, Benjamin Franklin, etc. Four months were taken up by the convention in its work; gradually difficulties were overcome and petty jealousies between the states smoothed over, and finally a constitution was agreed upon. Congress then sent a draft of the constitution to the various states for ratification since it was not to take effect until ratified by nine states. Three states adopted the constitution unanimously; three, by a large majority vote; three, by a small majority vote; one state, North Carolina, rejected it; Rhode Island refused to even consider it until certain amendments safeguarding the rights of the people had been adopted. (See graphic amendments I to X). The constitution went into effect January, 1789, the real date of the formation of the United States. North Carolina adopted the constitution in November, 1789; Rhode Island in May, 1790; so for eleven months North Carolina was not a part of the United States, for one year and five months Rhode Island was out of the Union. As showing the effects of national jealousies, note that the three states that adopted the constitution by narrow majorities,—Massachusetts, New York, Virginia,—were all leading states thus disinclined to sink their strong individualities in a union of all the states.

NATURE OF THE CONSTITUTION.

The constitution is a carefully guarded grant of power to the central government. It endows that government with certain limited powers and withholds all powers not so granted. The framers of it sought to express their meaning with all necessary clearness, but the legal effect of words is not always clear, and it has required the judicial decision of the supreme court of the United States for more than a century to make the real meaning of many of the provisions clear. Eminent constitutional lawyers still differ on many points of interpretation.

FEDERALISM AND ANTI-FEDERALISM.

As it now appears the Constitution is the result of three compromises provisions for which had to be made in the instrument itself before the different factions in the convention could reach an agreement. The first concerns the question whether there should be established a strong central government in which the states should be of minor importance; or, just the reverse, should the states themselves be real powers, separate entitles, loosely controlled by the central government. This was compromised (for the purpose of the convention, which served for time being only) by giving the executive great powers, but for a limited term only, and providing many checks on the exercise of that power by congress.

Those statesmen favoring a strong central government were known as Federalists; those in favor of a large degree of independence of the separate states were anti-Federalists.

THE COMPROMISE FAILED.

That compromise only touched the fringe of the real issue. It served to allay friction in the convention, but the same issue still confronts the people of the United States. Many minor issues were settled by the stern arbitrament of war; but that question is the one deep-seated, real but unnoticed issue that has divided all great political parties in our history. New crises required new measures and in the great crisis of the World War the central government was compelled to exercise powers that would have horrified Washington, Hamilton, and the Federalists generally—not to mention the opposition wing of the convention of 1787.

TO MAINTAIN THE BALANCE BETWEEN THE STATES.

The second compromise was that made to maintain the balance between the states. To illustrate, both Rhode Island and Virginia were independent states. In the new union what should be relations between them? If it were to be simply a question of area and population, Rhode Island would be far outclassed by Virginia. The compromise consisted in making congress to consist of two chambers and giving the states equal power in the senate irrespective of size or population, but giving them power in the house of representatives in proportion to their population. This compromise has been satisfactory.

CONSTITUTION IN FORCE.

The constitution became effective January, 1789. Washington was elected president; and the first congress of the United States was called to meet March 4th, 1789; but owing to the difficulties of transportation, a quorum of both houses was not present until April 30th, 1789, and Washington did not become legal president until that date; but since, theoretically, his term began March 4th, 1789, we have had a president inaugurated the 4th of March every fourth year since. It fell to the lot of Washington and the first congress to organize the new government, to launch it, and start it going. We need not pursue its history here, though it is a very interesting branch of study, that belongs to the constitutional history of the United States. The co-ordinate branches of government had to feel their way, as it were. Many questions at once presented themselves. Decades passed before the more pressing ones were settled: others of vast importance, were settled in the days of the Civil War. New questions are constantly arising. The constitution is not a completed instrument. It can be changed or amended by the states of the union, or its legal meaning differently defined by decisions of the supreme court.

CONSTITUTIONAL GUARANTEES.

Under the constitution every man has the privilege of freedom of speech and of opinion through the press. The people may assemble and petition the government to redress wrongs. Every one is entitled to a speedy trial by jury, with immunity from excessive bail or cruel punishment. No person may be held to answer for a capital or otherwise infamous crime unless upon indictment by a grand jury, and no person can twice be put in jeopardy of life or limb for the same offense. The accused has the right to be confronted with the witness against him, the right to compel the appearances of witnesses in his favor, and to have counsel for his defense. The rights of the people to be secure in their persons, houses, papers, and effects against unreasonable search and seizure is assured. No slavery or involuntary servitude shall exist except as punishment for crime. All persons born or naturalized in the United States are citizens thereof. No state may abridge the right of voting because of race, color or previous condition of servitude.

THE RIGHTS OF STATES.

Twenty-eight of our present states were territories before they were admitted to the union, others were admitted as states without passing through the experience of a territory. Thirteen were the original states, which by their union formed the United States. Statehood is not a matter of right, but a privilege granted by the general government. Once admitted to the union, there is no method provided for withdrawing. Throughout the union, the laws and judicial decisions of the United States take precedence over those of the state, provided the matter is rightfully referred to the United States courts for a decision. It is not within the province of an individual state to pass on the constitutionality of a law duly passed by congress; neither can it determine whether it will respect the law or not. Each state enjoys local self-government to the fullest extent, except in matters reserved to the federal government by the constitution. Each state is guaranteed a republican form of government and is to be protected against invasion by a foreign foe and against domestic violence.

LIBERTY OF ACTION WITHIN STATES.

The constitution states in what respects the right of suffrage shall not be abridged. In all other respects each state settles for itself the right of suffrage. Thus it is that in a large number of states women have the same rights of suffrage as men. In many other states they have a partial right of suffrage, while in others they are denied any right of voting. In still other matters of government the states differ. In quite a number of states the right of initiating legislative measures or of having the same referred to them for final decision, is reserved to the people; also in a number of states regularly elected officials can be recalled by the people before the expiration of the term for which they were elected, and in some states decisions by judges can be reversed by the people.

NUMBER OF OUR STATES.

There are now forty-eight states in the Union. According to the terms of admission of the state of Texas, which came to us as an independent nation, its great expanse of territory can, if the people so desire, be divided into four separate states. With that exception a state cannot be divided into two or more states; neither can separate states be united so as to form a single state unless both congress and the legislature of the states concerned agree to such acts. Both Alaska and the Hawaii Islands are now territories. It is possible that in the future other states may be admitted from such sources. It has been suggested that Porto Rico and our new possession, the Virgin Islands, be organized as a territory and so ultimately be admitted as a state. All states admitted to the union are on equal terms with the original thirteen states, thus there is no gradation among the states. Each state, no matter what its area or population, is entitled to two senators, and two only. The number of representatives depends on the population but no matter how small the population every state is entitled to at least one representative.

A UNION, NOT A COMPACT BETWEEN STATES.

One further point must be made clear. The constitution established an indissoluble union of independent states; it is not a compact between states. This was not clear at first. Ten years after the formation of the new government, Kentucky and Virginia adopted a set of resolutions expressly setting forth that the constitution is a compact, that each state being a party to the compact has the right to determine for itself the bearing of acts passed by the general government and to determine whether it should accept or reject them. When Jefferson was elected president there was some talk about New York and the New England states withdrawing from the union and forming a new union. In 1832 South Carolina declared of no effect a law passed by congress as far as South Carolina was concerned. Finally in days of the Civil War, ten states attempted to secede. Since then all thought of a compact between the states has been abandoned. Notice, this is only a variant of the old question of Federalism versus Anti-federalism that confronted the convention of 1787.

THE UNITED STATES GOVERNMENT.

We will now make a study of the government established by the constitution. We have a graphic analysis and we urge you to study it with care. By it you are enabled to visualize our scheme of government. The main divisions are the three co-ordinate branches of government, each of which has a work to do that the others cannot attend to. One branch is not higher than another, nor is its work of more importance. The success of our government depends on the harmonious co-working of these departments. With the aid of the graphic, and this comment on the same, endeavor to form a clear mental picture of the government under which we live. This will be of importance to you all through life.

THE LEGISLATIVE BRANCH.

The legislative branch of government is the branch charged with the duty of enacting laws necessary to carry on the government. We must distinguish between the constitution and the statutes of the United States. Laws are rules of actions; those passed by congress are designed to secure to the people their rights and to provide for the discharge of their duties in accordance with the constitution. This branch of the government is bi-cameral, that is, it is divided into two chambers, which exercise a mutual check on each other. They are given powers different in some respects.

THE UNITED STATES SENATE.

The Senate is quite often called the Upper House of Congress, its composition, rights and duties are set forth in the constitution and cannot be altered by legislation, only an amendment to the constitution can do that and only one amendment,—the XVII., dealing with election of senators,—has been made. It is the senate that preserves the equality of states in matters affecting all of the states, since each state sends two senators to congress. One can trace the influence of the old feeling that the states were independent nations in the senate. The senators are, theoretically, ambassadors from the individual states to the nation. Consequently, at first, they were elected by the legislatures of the several states. Representing in this special sense the states, they are given the right to refuse their consent to the president's appointees. The president nominates, among others, our foreign ministers and consuls, judges and important postal officials, and members of his cabinet, but it is necessary that the senate confirms the appointments. In 1913, the XVII Amendment of the Constitution, changed the method of electing the senators from the legislature of the states to the people of the states at large. A senator must be at least thirty years of age and have been nine years a citizen of the United States to be eligible to office. Senators serve six years each, but can be reelected.

SENATE CHAMBER, IN THE CAPITOL, WASHINGTON

RIGHTS AND DUTIES OF THE SENATE.

The presiding officer of the Senate is the vice-president of the United States. (See Graphic.) He does not have the right to a vote except in case of a tie. As presiding officer, he names the senate committees. The senate has as full rights in matters of legislation as the lower house except that all bills for raising revenue for the government originate in the house of representatives. The senate meets with the house when the electoral vote for the president is to be counted. The senate alone conducts impeachment trials.

THE HOUSE OF REPRESENTATIVES.

The House of Representatives is often called the Lower House of Congress. It consists of representatives elected by the people residing in the states which they represent. Each tenth year a census is taken in the United States to determine, among other facts, the population of the United States.

and the population of each state. When that population has been determined, congress decides what number of people shall be entitled to one representative, and thus we determine to how many representatives each state is entitled. At this writing, the number of people entitled to a representative is 212,407, and the total number of representatives is 435. The speaker of the house of representatives is its presiding officer. He is a member of the house elected by his fellow members. He has a vote only in case of a tie, but his office is one of dignity and power. Representatives must be at least 25 years of age to be eligible to office, they must have been citizens of the United States at least seven years, and must be citizens of the states they represent. They serve two years, but may be re-elected. Influential congressmen often serve a number of successive terms.

MEETING AND ADJOURNMENT OF CONGRESS.

Congress (both branches) must meet once each year, the date being fixed by the constitution, the first Monday in December. But it can be changed by majority vote. Congress continues in session until such time as it suits its convenience to adjourn, excepting that it adjourns *Sine die* the 4th of March of each odd numbered year. The president cannot adjourn congress, except in case the two houses should fail to agree in respect to the time of adjournment: he can convene both houses, or either house, as he thinks best in extra session whenever he deems it wise so to do; each presidential

THE HALL OF THE HOUSE OF REPRESENTATIVES.

year, the retiring president convenes the senate in extra session to meet the 4th day of March to consider the confirmations of the new president's cabinet and of such other officials as he may nominate for immediate confirmation.

POWERS OF THE LEGISLATIVE BRANCH.

Speaking now of both houses of congress, their powers to enact laws are based entirely on the constitution, which enumerate, among many other things, that congress shall have power to provide for raising taxes, the payment of debts, to regulate commerce between the several states, to provide laws for naturalization, to establish a postal system, to provide for the army and navy and all laws pertaining to them. Some things congress is expressly forbidden to do. For instance, it cannot suspend the writ of Habeas Corpus, nor pass a Bill of Attainder, nor enact an ex post facto law, nor lay an export tax.

One very important right conferred is the power to pass all laws necessary to make real the power of legislation expressly conferred on congress by the constitution; this leads to extensive legislation. To illustrate, the constitution asserts that congress shall have power to "regulate commerce among the several states." On that brief clause has arisen an enormous amount of Inter-State Commerce Legislation; and so of other powers conferred. It is impossible by any written instrument to map out fields of activity for what is necessary to carry laws into effect varies with changing conditions.

HOW A BILL BECOMES A LAW.

Let us suppose it is desired to enact certain regulations; that is to say, someone—or a body of people—desire to have a certain law passed. What they seek to accomplish is embodied in a bill, which must be put in legal form. It is then confided to some congressman (either a senator or a representative); he introduces it into the house (we will assume the House of Representatives). This introduction consists in reading the title of the bill with or without a few words of explanation. The bill is then referred to the committee having legislation of that character in charge. There the majority of bills are pigeonholed and are never heard from again, but we will suppose this to be a really important measure. In process of time it is reported back to the house with recommendations for or against its passage. The house now considers the bill and finally votes on it. If passed, it is next sent to the senate for its approval. The same course is pursued in the senate. It is necessary to remark that a bill may originate in either house, except that revenue bills must originate in the House of Representatives.

AN IDENTICAL BILL MUST PASS BOTH HOUSES.

The senate may agree to the proposed bill just as it came from the house, in which case it is promptly passed. They may wish to have it changed in some respects; in which case it is returned to the house for further consideration. The house may accept the proposed amendments, or they may disagree. In this case a Conference Committee is appointed, consisting of members of both houses. The committee generally agree on a compromise in which case, almost as a matter of course, both houses pass the bill as agreed upon in conference. At any rate the bill must finally be identical as passed by both houses.

WHEN IN THE PRESIDENT'S HANDS.

The bill is then sent to the president for his consideration, for the constitution is very explicit. Every action of congress requiring the concurrence of both houses (except questions of adjournment) must also be sent to the president for his approval or rejection. The president for some reason may not approve the bill. He has ten days (not including Sundays) in which to consider it. If he makes no move before that time limit, the bill becomes a law without his signature. If he disapproves it, he returns it to the house whence it originated with a statement of his objection. It once more has to run the gauntlet of both houses; but this time it must be passed by a two-thirds vote in which case it becomes a law without the president's signature. In the hurry of the closing days of a session, bills are often sent to the president a few days before the close of the session. In which case, if the president does not approve of a bill, all he need do is to let it lie on his desk until congress adjourns, when the bill is void, for the president has ten days to consider the bill, and this time being given him by the constitution, congress has no power to alter the time limit.

THE CONSTITUTIONALITY OF A BILL.

Even after a bill has passed both houses and been approved by the president, has been enrolled among the statutes of the United States and is in effect, it may run against a snag and be defeated. Some interested person or body of citizens may conclude the bill is contrary to the constitution of the United States, and so in the course of time the matter is brought before the supreme court for a decision. If a majority of the justices think the bill unconstitutional it is hopelessly defeated, even though it has been in effect for months or for years. Up to the year 1912, thirty-three acts of congress had been declared unconstitutional. Wishing to levy an income tax, congress enacted such a law. It was declared unconstitutional. To remedy that defect, the XVI Amendment (See Constitution Graphic) was adopted in 1913; now such taxes can be laid.

THE JUDICIAL BRANCH OF THE GOVERNMENT.

One must not confound this co-ordinate branch of government with the Department of Justice appearing on the graphic as one of the departments aiding the executive branch of government. It was necessary to provide in the constitution for a tribunal to consider cases arising between the different states of the union, to determine all strictly constitutional questions, and to provide for the legal transactions of the United States and foreign governments, accordingly it provides a Supreme Court and Courts of Inferior Jurisdiction. There is this difference between these two classes of courts. The supreme court is a constitutional court, congress cannot add to or detract from.its powers; the inferior courts are statutory courts, their organization was left to congress. In a measure, congress organizes the Supreme Court as well. It decides the number of justices that shall compose it and divides the United States into circuits. The constitution gives the Supreme Court original jurisdiction in all cases affecting "Ambassadors, other public Ministers and Consuls, and those in which a state shall be party," in those cases, congress has nothing to say; in all other cases arising under the constitution and laws of the United States the Supreme Court has appellate jurisdiction, and congress can regulate the procedure.

The judges of the Supreme Courts are called Justices; they are, at present, nine in number, one of whom is the Chief Justice. The judges in all United States courts are nominated by the president, and confirmed by the senate. They hold office during good behavior, in other words for life. At the age of sixty-two they may retire, if they wish, on full pay for the rest of their life.

UNITED STATES SUPREME COURT IN SESSION.

THE POWERS OF THE SUPREME COURT.

The question of Federalism versus Anti-Federalism, which we have explained, made its appearance very early in the history of the Supreme Court; it assumed this form—shall the court construe (or apply) the language of the constitution strictly or liberally? A strict interpretation would have eventuated in a relatively weak central government. Our present centralized government is in a large measure due to the liberal interpretation of the constitution by the supreme court, which sustained all acts of congress deemed necessary to carry into effect undoubted constitutional powers. To illustrate, the constitution says nothing about the supreme court deciding whether an act of congress is constitutional or not. The court under the guidance of Chief Justice Marshall pointed out that such a power was necessary to enable the court to exercise its undoubted power to determine questions arising "under the Constitution." So, as pointed out, the supreme court does have the power to decide on the constitutionality of an act of congress; not only that, if the question is properly before it, it can set aside a state act as being in conflict with the constitution of the United States. Down to the year 1912 more than two hundred such state laws had been set aside without consulting the wishes of the people in the states concerned. No other nation has a supreme court that is a co-ordinate branch of government and exercises such powers as our supreme court.

THE EXECUTIVE BRANCH OF GOVERNMENT.

All nations have a chief executive who may be styled the general manager of the nation, one who directs the activities of the nation, one whose duty is to see that the wishes of the nation expressed through congress are carried out. Our constitution accordingly provides that the executive power of our government shall be vested in a president who holds his office four years. There is no constitutional bar to re-election for successive terms; custom, however, following the example of Washington, has been a virtual bar to more than two terms. One to be eligible to the office of president must be a natural born citizen of the United States and be at least thirty-five years of age.

METHOD OF ELECTING A PRESIDENT.

The method followed in electing a president was settled by the constitution and can only be altered by an amendment, but one of which, pertaining to that subject, has been adopted (12th Amendment), so that in the main we still elect our president according to the method adopted in 1789, though it is entirely out of date. We must reflect that the makers of the constitution knew but little about political parties, nothing about party conventions (all that was far in the future) and were under the influence of the old idea that the states were separate, independent nations, so they provided a method of election that was very wise, theoretically; unnecessarily complex practically, which has continued because it was the method set forth in the constitution, but the spirit of the measure never active except in the case of Washington, entirely disappeared, as political parties, nominating conventions, and party platforms came into vogue.

THE ELECTORAL COLLEGE.

Each state is directed to appoint, in any manner it deems best, a number of its citizens,—equal to its total representation in congress—to act as presidential electors. The electors for each state are supposed to meet in their respective states and cast their vote (at first) for two persons. Votes from all of the states are sent to Congress, there opened and counted, and (down to 1803) the individual receiving the highest number of votes became president, provided his votes were a majority of all the votes cast, the second highest one on the list became vice-president. We have not space to explain minor details of this method. It was changed by the XII Amendment to the Constitution in 1804 to this extent; the electors vote directly for one person for president and one for vice-president.

DUTIES OF THE PRESIDENT.

The president is the general manager of the greatest organized business in the world —the United States. The constitution does not specify how this vast business shall be organized, it mentions, however, "executive departments," so at present the business of the United States is conducted by means of ten executive departments, the heads of which constitute the president's cabinet and meet with the president in frequent sessions to report on any matter of importance concerning the several departments, and to counsel with him on national affairs. In addition, there are a number of commissions and boards to attend to important matters, not included in any of the departments.

EMERGENCY BOARDS.

Under the pressure of war needs congress authorized the formation of a number of emergency boards, conferring on them a variety of powers. The president then organized the boards, and they proceeded to carry out the purposes of their formation. In doing this they assumed certain rights, some of them might or might not have been constitutional, but in times of great emergency one duty is above all others, the duty to preserve the nation. The most important of these emergency boards were: The Council of National Defense, War Industries Board, The Food and Fuel Administration Boards, The Shipping Board, and the Aircraft Production Board. The boards were organized to assist the president more efficiently to fulfill his duties as commander-in-chief of the army and navy.

THE PRESIDENT'S MESSAGE.

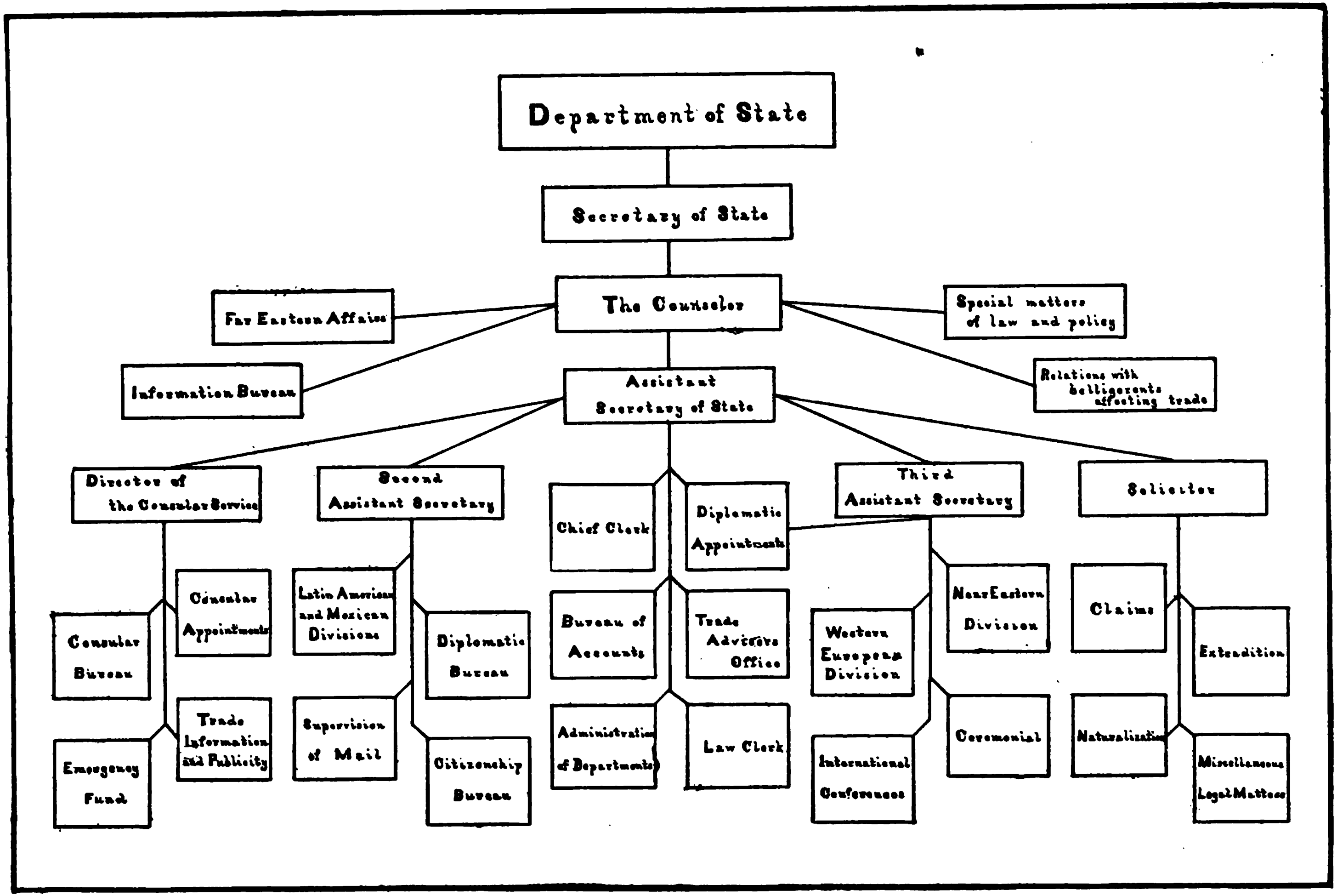
The head of each executive department makes a written report to the president each year of affairs in his department. Thus informed, the president is directed to give to congress information as to the state of the union and to recommend such measures as he shall judge necessary and expedient. Such a message is expected at the annual meeting of congress in December. The president may, however, prepare such a message for congress at any time he deems it necessary. Theoretically, the president is not supposed to influence legislation. As a matter of fact he can and does exercise a great influence on legislation. We have but to consider the administration of such a president as Woodrow Wilson to see how true is this statement.

ITEMS OF INTEREST ABOUT PRESIDENTS.

Beginning with 1788 down to, but not including, 1920, there were thirty-two presidential elections; but only twenty-seven different citizens filled the office of president; nine presidents were elected a second time; five presidents died in office (three of them being assassinated) and were succeeded by vice-presidents, one only of those vice-presidents received the honor of being elected to succeed himself as president. Two of the presidents sustained the relation of father and son; two, that of grandfather and grandson. One president had the unique distinction of serving two terms, with the term of another president intervening. One president only has ventured to leave the United States while president to serve on a diplomatic mission abroad. Two presidents visited the Panama Canal Zone during their term of office, but, technically, that was not leaving the United States territory. One president faced the humiliation of an impeachment trial. One president served only one month, one only six months. The youngest man to serve as president was not quite forty-three years old when his term began.

DEPARTMENT OF STATE.

All executive departments are designed to assist the president in the discharge of his work. There is not an elected official connected with them; the chief officer in each department is nominated by the president and confirmed by the senate. They are the president's personal representatives and are subject to dismissal whenever he wishes. Should they wish to resign, they direct their resignation to him. Each secretary is the


Department of State
Secretary of State
The Counselor
Far Eastern Affairs
Information Bureau
Special matters of law and policy
Relations with belligerents affecting trade
Assistant Secretary of State
Director of the Consular Service
Second Assistant Secretary
Third Assistant Secretary
Solicitor
Chief Clerk
Diplomatic Appointments
Bureau of Accounts
Trade Advisers Office
Administration of Departments
Law Clerk
Consular Appointments
Consular Bureau
Trade Information and Publicity
Emergency Fund
Latin American and Mexican Divisions
Diplomatic Bureau
Supervision of Mail
Citizenship Bureau
Western European Division
Near Eastern Division
International Conferences
Ceremonial
Claims
Extradition
Naturalization
Miscellaneous Legal Matters

official head of his department. Should you chance to visit Washington, you will find that the business of the State Department is transacted in one of the largest and most magnificent office buildings in the world. Hundreds of clerks are busy with the numberless details connected with it.

SECRETARY OF STATE.

The secretary of State is charged with duties appertaining to correspondence with the public ministers and the consuls of the United States and the representatives of foreign governments accredited to the United States and to negotiations of whatever character relating to the foreign affairs of the United States. He is also the medium of communication between the president and the governors of our several states. He is the custodian of the great seal of our country and affixes it to all executive proclamations and to some other state papers, such as warrants for the extradition of fugitives from justice. He is also the custodian of treaties made with foreign nations. He issues passports, publishes the laws and resolutions of congress, proclaims the ratification of amendments to the constitution. The secretary of state is popularly called the head of the cabinet, sometimes he is spoken of as the American premier. In affairs of ceremony and in the order of succession to the presidency he is, in truth, the head of the cabinet, but in no other sense of the word is he of more authority than any other cabinet officer.

THE COUNSELOR.

Notice from the graphic the counselor. As his title indicates he advises the department of state on matters of law and policy that are of especial importance. He is generally one who has had long experience in the department, but he is appointed by the president, confirmed by the senate. Notice he has oversight of Far Eastern affairs, that is of affairs concerning Japan and China particularly, which are of special importance, since we face these countries across the Pacific, and by reason of our possession of the Philippine Islands and brought in close touch with those people and questions of immigration are constantly arising. On several occasions we have been near to war with Japan over these questions. He also has charge of Relations with Belligerents affecting Trade, and is charged with the conduct of the Information Bureau of the department. The counselor ranks next to the secretary of state.

THE ASSISTANT SECRETARY OF STATE.

The assistant secretary of state is the official that has charge of the vast routine work of the department. The time of the secretary of state is occupied with questions concerning foreign relations of great importance; he is busy consulting with the president or with the representatives of foreign governments stationed at Washington. The assistant secretary of state attends to the necessary details of department work. Notice the organization of the department into sub-departments and bureaus. The assistant secretary has power to act as secretary during the latter's absence, or when that office is not filled. He has other assistant secretaries to assist him, for with our development as a nation the original scope of this department has become greatly enlarged.

THE SOLICITOR.

The solicitor is the law officer of the department and renders opinions in all matters referred to him, but notice that all matters directly concerning foreign governments are referred to the counselor. The solicitor has supervision over claims. He is not the final authority in cases of disputed claims of a certain class since these may be carried to the court of claims with the right of appeal on questions of law to the supreme court. He manages extradition proceedings and is in charge of the legal aspects of naturalization. He is under the jurisdiction of the department of justice, but he has duties assigned to him by the secretary of state.

THE CONSULAR SERVICE.

On the left of the chart, we notice the Bureau of Consular Service. In virtually all the important cities of the world consular representatives of the United States are stationed. Consuls are our commercial agents in foreign lands. It is a consul's business to provide for destitute American sailors and send them home; to take charge of the effects of American citizens dying in his jurisdiction and having no legal representatives; to keep a record of the arrival and departure of American ships and of their cargoes; and in his report to convey all useful information relating to manufactures, population, and other matters that may affect the trade and commerce of the United States. In addition to these duties consular offices in some non-christian countries (such as Siam, China and Morocco) are given by treaty judicial powers over American citizens in those countries. Notice that one of the departments of this service is that of Trade Information and Publicity. It is the business of that office to spread abroad information received from the consuls. Consuls are of different grade, according to the importance of the place to which they are accredited. A consul-general is the most important grade. He has jurisdiction over several consuls. Commercial agents are accredited to smaller places. It is evident that consular service is very important and you notice a Bureau of Consular Appointments. But that only has reference to necessary business directly connected with the appointment. The constition directs that the president shall appoint consular officers, subject, as usual, to confirmation by the senate. The consular service is now governed by civil service regulations.

DIPLOMATIC APPOINTMENTS.

Directly underneath the rectangle of the assistant secretary of state, we note the departments among whom the immediate work of his office is apportioned. We call attention to but one of these bureaus, that of Diplomatic Appointments. Notice it is also connected with the Third Assistant Secretary, the reason becomes very apparent when we consider the work of that office. Our diplomatic representatives are agents of our country at foreign courts. They are of various classes, of which ambassadors rank the highest being sent only to important nations, as Great Britain; at other courts our country is represented by ministers, as minister to Holland. Envoys extraordinary, or ministers plenipotentiaries, are sent on special errands under special circumstances. This bureau has charge over applications, examinations, and appointments to diplomatic service, however, the president is directed by the constitution to appoint ambassadors and other public ministers subject, as usual, to confirmation by the senate.

SECOND ASSISTANT SECRETARY.

To the left of the center of the chart note the office of the Second Assistant Secretary, and directly underneath the divisions among whom the work of his office is apportioned. Observe, he has charge of Latin-American and Mexican affairs. On subsequent pages you will find a very full description of the twenty-two nations composing Latin-America. The great importance of the work of the sub-department is clear; that work will increase in importance from now on, for Latin-America will assume a more prominent place in world activities as time passes. Observe, also, the Diplomatic Bureau under the oversight of the Second Assistant Secretary. That bureau has oversight of the diplomatic service at large, it arranges ceremonies attending the making of treaties, has charge of preparation of diplomatic correspondence with foreign governments, and other diplomatic matters of importance.

THIRD ASSISTANT SECRETARY.

To the right of the center of the graphic, is represented the work and organization of the business of the Third Assistant Secretary. Observe, that his office transacts our foreign affairs with the nations of Western Europe and the near Eastern nations; thus, generally, the nations of Asia, excepting China and Japan.

Considering the nations with which this sub-department is in touch we readily understand why the bureau of diplomatic appointments is under the joint oversight of the assistant and third assistant secretary of state. Notice also the division of International Conferences. There have been a number of such conferences in the past, there will be others in the future, our participation in the same is under the oversight of the third assistant secretary.

OFFICIAL COMMUNICATIONS.

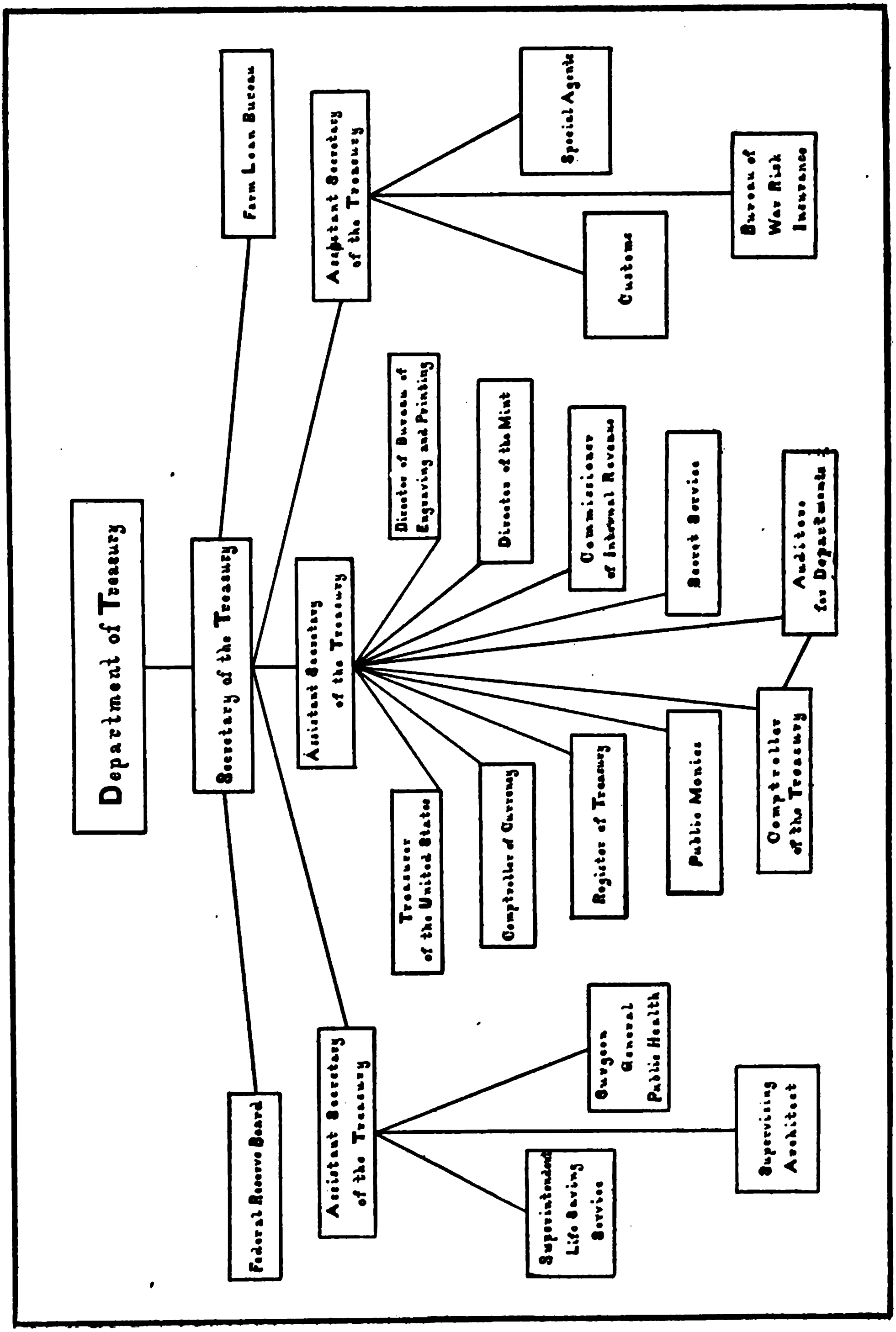
Important communications are constantly arriving at the department. They are opened by the chief clerk and are sent by him to the secretary himself, to one of the assistant secretaries, or to the diplomatic bureau according to their importance. The diplomatic bureau prepares a reply. It may be prepared in accordance with instructions from higher sources. The reply is then sent to the secretary for his approval. Important dispatches on international affairs as prepared by or for the secretary are generally the subject of a cabinet discussion, and at all events the subject of a conference with the president who is kept fully informed of matters of importance and may take upon himself charge of important dispatches.

DEPARTMENT OF TREASURY.

The treasury department is the executive branch of government that attends to the financial business of the United States. The vast amount of detail that must be attended to is evident for transactions running into the billions of dollars, are now almost commonplace matters with the treasury. Like all departments of our government it had developed from small beginning until it is now one of the greatest financial institutions in the world. When our government was organized in 1789, our public debt was about $75,000,000. Washington confessed that he did not know "what to do with this heavy debt." Nowadays, our treasurer would not give such a triffling amount more than a passing thought; just quietly instruct some bureau clerk to pay it.

THE GRAPHIC OF THE TREASURY DEPARTMENT.

Like all executive departments, the treasury is systematically organized for the trans-


Department of Treasury
Secretary of the Treasury
Farm Loan Bureau
Assistant Secretary of the Treasury
Special Agents
Bureau of War Risk Insurance
Customs
Assistant Secretary of the Treasury
Director of Bureau of Engraving and Printing
Director of the Mint
Commissioner of Internal Revenue
Secret Service
Auditors for Departments
Comptroller of the Treasury
Public Monies
Register of Treasury
Comptroller of Currency
Treasurer of the United States
Federal Reserve Board
Assistant Secretary of the Treasury
Surgeon General Public Health
Supervising Architect
Superintendent Life Saving Service

action of business. Examining the graphic, we note at the head of the department a Secretary of the Treasury. Do not confound him with the treasurer of the United States. The secretary is appointed by the president, confirmed by the senate, and is a member of the cabinet. He has general oversight of his department and large discretion in a few directions, but in effect he is managing a very large bank with congress for his board of directors, and they lay down explicit rules for him to follow. He is not chosen by his directors and often is out of sympathy with them. Congress may legislate, the president only can execute; and the secretary of the treasury is the president's personal representative attending to the financial affairs of the nation. He is charged by law with maintaining the revenue for the support of the public credit; superintending the collecting of the revenue and directing the forms of keeping and rendering public accounts; granting of warrants for all money drawn from the treasury in pursuance of appropriations made by law and for the payment of money into the treasury and annually submitting to congress estimates of the probable revenues and disbursements of the government. He also controls the construction of public buildings, and the coinage and printing of money.

THE FEDERAL RESERVE BOARD.

Examining the graphic, we note two bureaus of importance recently instituted by congress, whose general oversight is necessarily the duty of the treasury. The first is the Federal Reserve Board, which was instituted in 1913. It necessitated great changes in the old national bank system. It consolidates the nation's banking resources, in such a way that credit and currency are available wherever and whenever needed. It is generally agreed that it was this new department that enabled our country to withstand successfully the financial strain of the World War. The affairs of this bureau are managed by a board of seven members appointed by the president, of whom the secretary of treasury and the comptroller of currency are ex-officio members.

THE FARM LOAN BUREAU.

The Farm Loan Bureau is another recent enlargement of the activities of the treasury department, it is designed to assist the agricultural interests of our country and is of great importance since agriculture is the basic industry of our country. Taking advantage of this board, farmers can secure loans on advantageous terms. Hundreds of millions of dollars have already been loaned. All of this business is under the supervision of the Farm Loan Bureau of the treasury department. This bureau consists of five members of whom the secretary of the treasury is ex-officio chairman.

ASSISTANT SECRETARIES OF THE TREASURY.

There are three assistant secretaries of the treasury, who are theoretically of equal rank and are distinguished in the administration of the department as secretaries A. B, and C. On the graphic is shown the manner in which the work of the treasury is divided among them. We notice that one (on the left) has charge of activities that, at first, seem to have little relation to the treasury department,—such as Life Saving Service, that of the Public Health, and the Architect's department; one (in the center) has general oversight of the administrative activities of the treasury department; while another (on the right) has charge of special branches of the general work as Customs, Special Agents, and War Risk Insurance.

In general terms, we may say that the treasury department receives all money due to the government, and pays out all money due from it, keeping a book account of all these transactions; it is, so to speak, the central plant from which all other departments get their power. Broadly speaking, the only way the government can obtain money is by taxation, which, as we know, assumes multitudinous forms. In times of great financial need the government has to borrow money, or, in other words, sell bonds; but bonds are simply evidence of indebtedness, which will have to be paid later, and the money to do it can only come from taxation. The enormous supplies of money, running far into the billions, needed for war purposes, had to pass through the treasury and records were kept of the incoming and outgoing amounts. Appropriation bills, passed by congress, are the only authority for paying out money from the treasury.

Printing money at the Bureau of Engraving and Printing. The plates are engraved by the finest engravers in the world, and are turned over to the printers. When the money is printed it is sent to the Treasury under guard and deposited in the vaults.

THE TREASURER OF THE UNITED STATES.

The officer immediately in charge of, and responsible for, the public moneys is called the treasurer, and the rooms and vaults in the treasury building of Washington used by him, and such other apartments as are provided for the deposit of public money, are called the "Treasury of the United States." He is charged with all money in all depositories. He endorses his receipt upon all warrants for money paid in; he pays out money only upon warrants drawn upon him. His other duties are various, among others, he is required to pay the interest on the public debt, to receive the United States notes, to issue new notes for notes returned and destroyed by him, to act as custodian of the United States bonds deposited with him for various purposes. He is charged with the issue, exchange, transfer, and redemption of bonds and the receiving and registering of redeemed notes, certificates, coupons, etc.

THE COMPTROLLER OF THE TREASURY.

A comptroller is one who controls; notice, there are two comptrollers. The comptroller of the treasury controls the payment of money. He passes upon the payment of all accounts that may be appealed to him, and his decisions are final; however, civil law courts may review his decisions, if the matter is properly before them, and the secretary of treasury may suspend payment on a warrant he has passed, and order a re-examination. All warrants for the disbursements of money must be passed on by him. The Comptroller of the Currency has control of national banks. Banks cannot open for business until they receive his certificate. Reports are made to him by all banks. All bank examiners are under him. In case of national bank failures he takes charge. He controls their currency issues.

MAKING UNITED STATES MONEY.

Gold is the basis of all United States money, because it is accepted as the measurer of value all over the world. All other forms of money in the United States, whether paper or silver are representative money only. They are paper or silver notes, which the treasury stands ready to redeem at any time when demand is made in gold for their face value. Coining of gold and silver, or printing of paper money is the exclusive right of the treasury department. Coining gold and silver is done at various United States mints, under charge of the Director of Mints, which we notice is one of the bureaus represented on the graphic. The work of this bureau is of such interest that it is made the subject of special treatment on subsequent pages.

BUREAU OF PRINTING AND ENGRAVING.

All of our paper money is made by the treasury department, through the Bureau of Engraving and Printing. There are printed all national bank notes, greenbacks, gold and silver certificates, stamps of all descriptions,—revenue, postal, and war saving stamps,—and all our national bonds. The plates used for this purpose are the finest in the world, made by high class workmen; the paper is a special paper made solely for this purpose. A close record is kept of every sheet of paper brought to the bureau. A spoiled sheet must be kept and an account made of it. In the process of printing, as the sheets pass from one operator to another. receipts are given. When completed, each sheet represents a number of National bank bills, or United States notes, or bonds, and are sent, under guard, to the treasury where they are stored in vaults where thieves cannot break through and steal, nor yet fire destroy.

BUREAU OF WAR RISK INSURANCE.

Notice in the graphic the Bureau of War Risk Insurance. This was organized in the early days of the World War. It is divided into two branches. The first is life and disability insurance of soldiers and sailors. Our government has gone into the insurance business. Policies are issued, on which premiums are paid as in other companies. In less than two years there were many billion dollars of policies in force. Arrangements are made to keep up the insurance in times of peace. Another branch is the marine insurance of shipping and commerce, and insurance of officers and seamen of our merchant marine.

OTHER BUREAUS.

A large part of the revenues of our government is derived from import, or custom duties, that necessitates that the treasury exercises a measure of oversight over all ports of the United States and have at its disposal revenue and lighthouse cutters. On the left of the graphic, notice bureaus that you would think at first glance had no connection with the financial affairs of the government. The supervising architect's office is under the oversight of the department, because it must pay for the buildings authorized by congress.

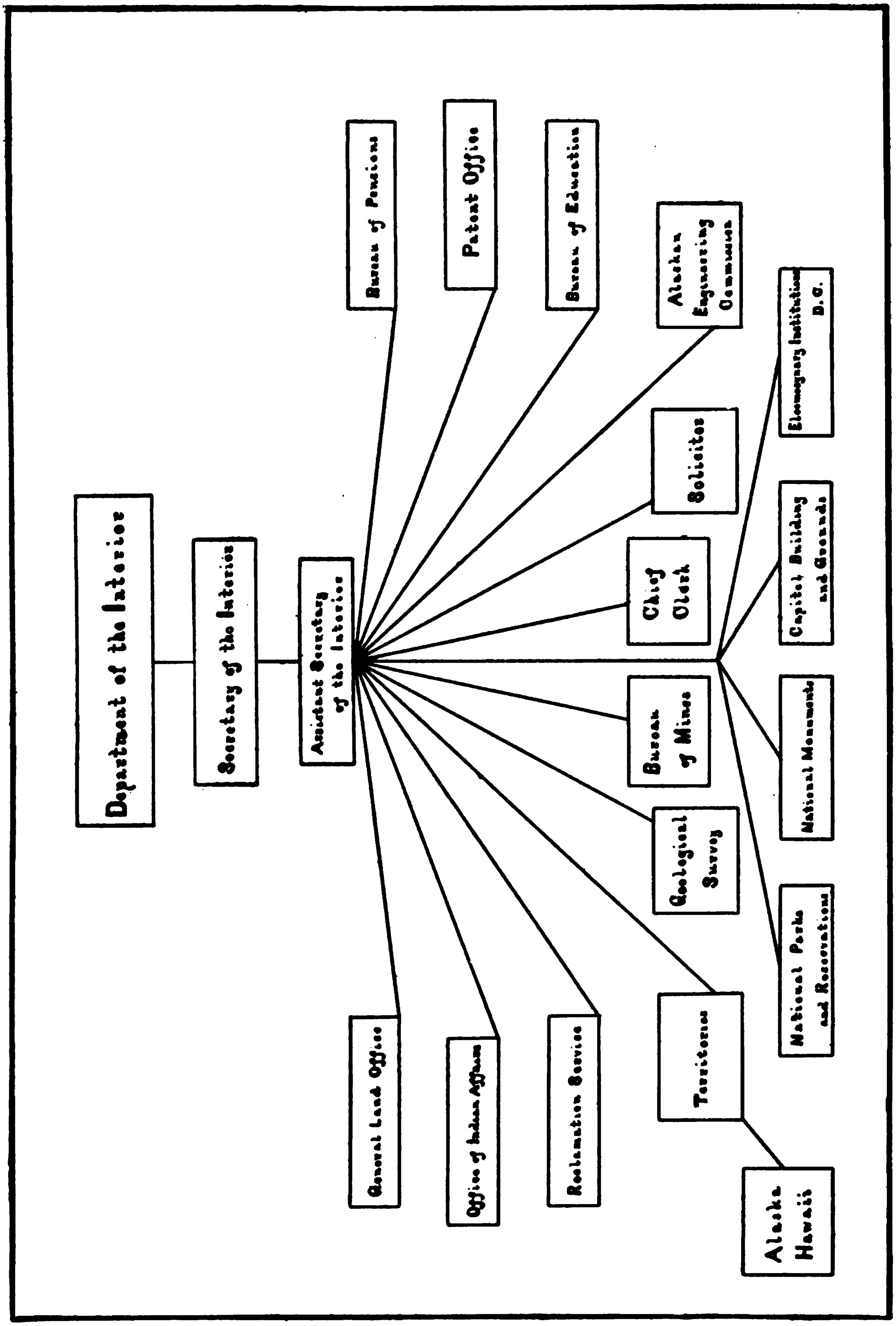
The Secret Service Bureau is entrusted to this department, because it has needs for most of the work of this bureau. It must guard against counterfeiting, violation of internal revenue laws, and smuggling. Every traveler landing in the United States from abroad must pass inspection by agents of this department. It is the secret service bureau that constantly guards our president from possible attacks. Attention is also called to the office of auditors for the departments. Since the treasury has to pass on the accounts of all the departments, it is necessary to have someone supervise them. The auditors determine the proper forms of all accounts in the various departments of governments as well as investigate them thoroughly.

DEPARTMENT OF THE INTERIOR.

The Department of the Interior has general oversight of the domestic affairs of the United States, those in which only this country is concerned and thus distinct from foreign affairs. A glance at the graphic makes this statement plain. The seventeen offices, among whom the business of the department is apportioned, are seen, from their titles, to be intrusted with United States business alone. But it is also clear that this business is so various and important that this department is one of the most important we have. The Secretary of the Interior must pass finally upon questions of patent law, pension law, land law, mining law, the construction of Indian treaties and many other questions, calling for expert legal knowledge. There is, you notice, an Assistant Secretary of the Interior who, with his chief clerk, attends to the details of the department work. We must consider the work of the more important bureaus.

GENERAL LAND OFFICE.

There are seventeen states of our Union in which there was never any land belonging to the United States,—the original thirteen states, and Kentucky, Maine, Vermont and Texas. In explanation, we must recall that Texas came to us as an independent nation and reserved for her own use all her public land; Kentucky, Vermont and Maine were formed out of territory that belonged


Department of the Interior
Secretary of the Interior
Assistant Secretary of the Interior
Bureau of Pensions
Patent Office
Bureau of Education
Alaskan Engineering Commission
Eleemosynary Institutions D.C.
Solicitor
Chief Clerk
Capitol Building and Grounds
Bureau of Mines
National Monuments
Geological Survey
National Parks and Reservations
Territories
Alaska
Hawaii
General Land Office
Office of Indian Affairs
Reclamation Service

to one or more of the original thirteen states and all the land in their boundaries was given to the states concerned, not to the general government. But, broadly speaking, the land in all other states belonged to the general government, though large areas of territory received from Mexico were held under private grants from Mexico which the treaty confirmed. The General Land Office of the United States has general oversight of the public land of the United States. All homestead questions are adjusted by this bureau, all details necessitated when Indian reservations are opened, applications for power sites in the public domain, or town sites in Alaska are passed on by this bureau.

AN HISTORICAL LAND OFFICE.

We have developed so rapidly as a nation that we scarcely realize that less than a century ago the larger part of what is now the United States, was simply public land of the general government or belonged to other nations. There is still standing at Marietta, Ohio, the first general land office established by the United States to dispose of public land, in what was then the Northwest Territory, including all territory north and west of the Ohio River,—in the days when there was no Ohio or Indiana; no Illinois, Michigan or Wisconsin; when all west of the Mississippi belonged to France and Spain.

DISPOSITION OF PUBLIC DOMAIN.

There are still immense areas in the United States unappropriated, not including Alaska, thousands of square miles of which are as capable of tillage as much of Scandinavia in the same latitude. From 1787 to the year 1918, 340,000,000 acres had been taken up under the homestead law; 176,000,000 acres are reserved in National Forests; about 6,350,000 acres are reserved in National Parks and Monuments; 133,000,000 acres were given to the individual states for educational purposes; a great many million acres are reserved for the general use of the government. It is evident that the United States has been liberal in the matter of land, but the days of abundant fertile land for homestead purposes are over; however, in these days of scientific irrigation, dry farming, and educated plants,—like Kaffir corn and spineless cactus,—it is a question whether there is any land that cannot be made productive. There is today over 50,000,000 acres of public land in Nevada at present considered worthless. It is quite possible that before many decades that land will become as valuable as former desert lands in Salt River Valley, Arizona, now worth hundreds of dollars per acre.

RECLAMATION SERVICE.

The Reclamation Service while not a division of the land office is in close connection with it. It has charge of the various irrigation projects. When the projects under construction shall be fully utilized a total area of over 3,000,000 acres will have been brought under cultivation by this branch of the service. That is equivalent in area to a state as large as Connecticut, before worth but little, now among the best land we have. And we are continually discovering sections where some irrigation methods can be applied. A great deal of underground water can be used by artesian well projects. It is evident that this bureau is in charge of a very important branch of internal affairs. The Salt River Valley in Arizona was formerly a near desert expanse; now thousands of farmers in that section are raising millions of dollars worth of produce in a country as fertile as Egypt. Some projects require immense reservoirs. The largest storage reservoir in the world is the Elephant Butte Dam in New Mexico. It stores sufficient water to cover the state of Delaware two feet. It blocks a canyon of the Rio Grande 120 miles north of El Paso. It will irrigate, and thus restore to fertility, 185,000 acres of land.

BUREAU OF TERRITORIES.

As has been pointed out, we have two territories,—Alaska and Hawaii. The governors of these territories make their reports to the Interior Departments and we notice a bureau that has oversight of them. Both of these territories have been fully considered on previous pages. On the right of the graphic we note the department of Alaska Engineering Commission. That commission has charge of railroad construction in Alaska; one being in process of construction from Seward, Alaska, to Fairbanks, intended to open the coal fields of the Matanuska and Susitma valleys. Homesteads are being taken up in these valleys and bountiful crops of potatoes and the hardier vegetables are raised. Every year is demonstrating more clearly the value of this territory. The value of the fisheries alone, amounts each year to four times the total first cost of Alaska; the value of the mineral mined each year is more than six times that cost. It is truly a land of wonderful possibilities. The only part of the United States where the midnight sun shines down on a sleeping world; where flaming volcanoes and glacier filled valleys are near neighbors; off its shores are the most valuable fishing grounds in the world; and there also disport hundreds of thousands of fur-bearing seals and great schools of whales.

OFFICE OF INDIAN AFFAIRS.

We are so accustomed to think of the Indians as a dying race that it is with surprise that we read that they now number 335,000; that their birth rate exceeds that of death, and that some scholars think there are as many Indians in this country as when the Pilgrim Fathers landed at Plymouth. The total land reserved for their occupation is 71,000,000 acres or some more than the combined areas of New England and New York; in the various Indian schools nearly 65,000 children are receiving very practical education, in which manual training and agriculture are given great attention; finally the total wealth of the Indians is more than $650,000,000. The richest people in the world, estimated by per capita wealth, are the Osage Indians in Oklahoma, their average wealth is fully $10,000, the lowest income of any members of the tribe is at least $5,000 annually, while some have incomes much larger. Indians fought bravely in the World War; Indian scouts did exceptional work,—they never lost their way in darkest night,—one of the aviators in our ranks was an Indian, and one of the best lieutenants in the Canadian service was full blooded Indian from the United States.

DUTIES OF THE INDIAN BUREAU.

But the Indians still are our national wards and the general oversight of their affairs is intrusted to the Office of Indian Affairs. This office guards their land interests, makes allotment when necessary, sells off surplus land, considers irrigation projects, looks after their schools and has charge of their reservations. The reservations are mainly in the West, the two principle ones being located in Oklahoma and Arizona, but every state west of Mississippi has one or more Indian reservations. There are about 7,000 Seneca Indians in New York, but the State of New York has their interests in charge. Florida has just set aside 100,000 acres for the use of the Seminole Indians who, in defiance of treaty arrangements of nearly a century ago, persisted in staying in Florida.

INDIAN STUDENTS AT THE GOVERNMENT SCHOOL.

GEOLOGICAL SURVEY AND BUREAU OF MINES.

These two bureaus are closely related and yet they are entirely separate bureaus. The Geological Survey was organized to determine the classification of the public lands, and to examine the geological structure and determine the mineral resources and products of the national domain. This bureau has grown in scientific interest and has become the national bureau for information on geological education. It has done an immense amount of scientific work. Its value was emphasized in the World War. It was this bureau that called attention to the immense potash deposits at Searles Lake, California. Our iron pyrites from Spain (needed to manufacture sulphuric acid) were shut off by the war, the geological bureau knew where pyrites existed in the Appalachian sections and in 1918, 1000 tons a day were being produced from mines opened there.

OIL BEARING SHALES IN THE WEST.

Considering the enormous amounts of petroleum now required, about 300,000,000 barrels being produced yearly in the United States, the Geological Bureau made a survey of oil prospects in our country. In this way attention has been called to supplies, virtually inexhaustible in amount, in the shales of Utah and Colorado. The shales are great masses of sedimentary rock that some time in the past were saturated with coal oil that must have existed in unbelievable quantities in connection with coal deposits of which the coal beds of today, vast as they are, represent only a fraction. In process of time these great layers of shale were upheaved in mountain formation and so we have in the hills and mountains of Utah, Wyoming and Colorado billions of barrels of oil waiting to be set free from the shale. The oil is not gained by drilling wells but by distilling the shale, by which we secure, not only quantities of oil, but vast quantities of valuable by-products. The bureau estimates that in one region, the Uinta Basin, towards the Greene River in Utah, there are 40,000,000,000 barrels of petroleum waiting distillation. All the petroleum produced in the United States prior to 1920 was about four billion barrels. In this one section, then, is about ten times as much petroleum stored away for future use.

BUREAU OF EDUCATION.

The Bureau of Education is one of the bureaus of the Interior. It does not have oversight, as we might suppose, of education in the states, because that is a matter entirely of state control, but it does assemble statistical information of all kinds bearing on education matters to disseminate among the schools of our land, and it carries out many educational projects such as school surveys in rural sections and in cities requesting its aid. This bureau also lends its influence to special subjects of education as vocational education in the United States and school-home-garden projects. During the World War when increased production of food was deemed of great importance, 34 cities reported 67,000 children engaged in home-school garden work, raising $142,000 worth of produce. This bureau is charged with the education of the natives of Alaska. The education given is necessarily very elementary but on the other hand it is intensely practical. It is social settlement work of the first class,—home making, home sanitation, the elementary comforts of civilization. It was this board that introduced reindeer into Alaska. There are now nearly 100,000 of them in that territory and they are doing for the Eskimos just what flocks and herds did for our prehistoric ancestors—civilizing them. The most northern school-house in the world is in Alaska, and that land is the only place in the United States territory where the superintendents of schools make their inspecting trips by the aid of dog sleds and reindeer teams.

OTHER DEPARTMENTS.

On the graphic we notice other bureaus and offices. The Patent Office has been made the subject of a special article. We also note that it is the Interior department that has charge of Pension matters. This is the bureau whose business will at once greatly increase as a result of the 1917 war, which is the official title of the World War, on the pension bureau's books.

We call attention to the National Parks and Reservations and National Monuments. Under the general supervision of these offices are 22 National Parks and 17 National Monuments,—there are 13 more monuments under the charge of the War and Agriculture departments. The most important national parks are considered in a special section. The total area of our national parks surpasses the combined area of Massachusetts and Rhode Islaand. This area is set aside for the use of the people of the United States, a great out-of-doors sanitarium of wonderful scenic attraction, far more impressive than the best the old world possesses.

Courtesy of the Interior Department.

MOUNTAINS OF OIL.

In the shales of Colorado nature has deposited such vast amounts of petroleum that all other supplies are insignificant. It is estimated that there are 20,000,000,000 barrels of oil stored in these shales. The Government has set aside 132,000 acres of the richest oil bearing shale rock as a source of supply for the United States Navy. By distillation these shales yield from forty to fifty gallons per ton of oil, in addition hundreds of millions of tons of sulphate of ammonia, of untold value as a fertilizer, being a source of nitrogen.

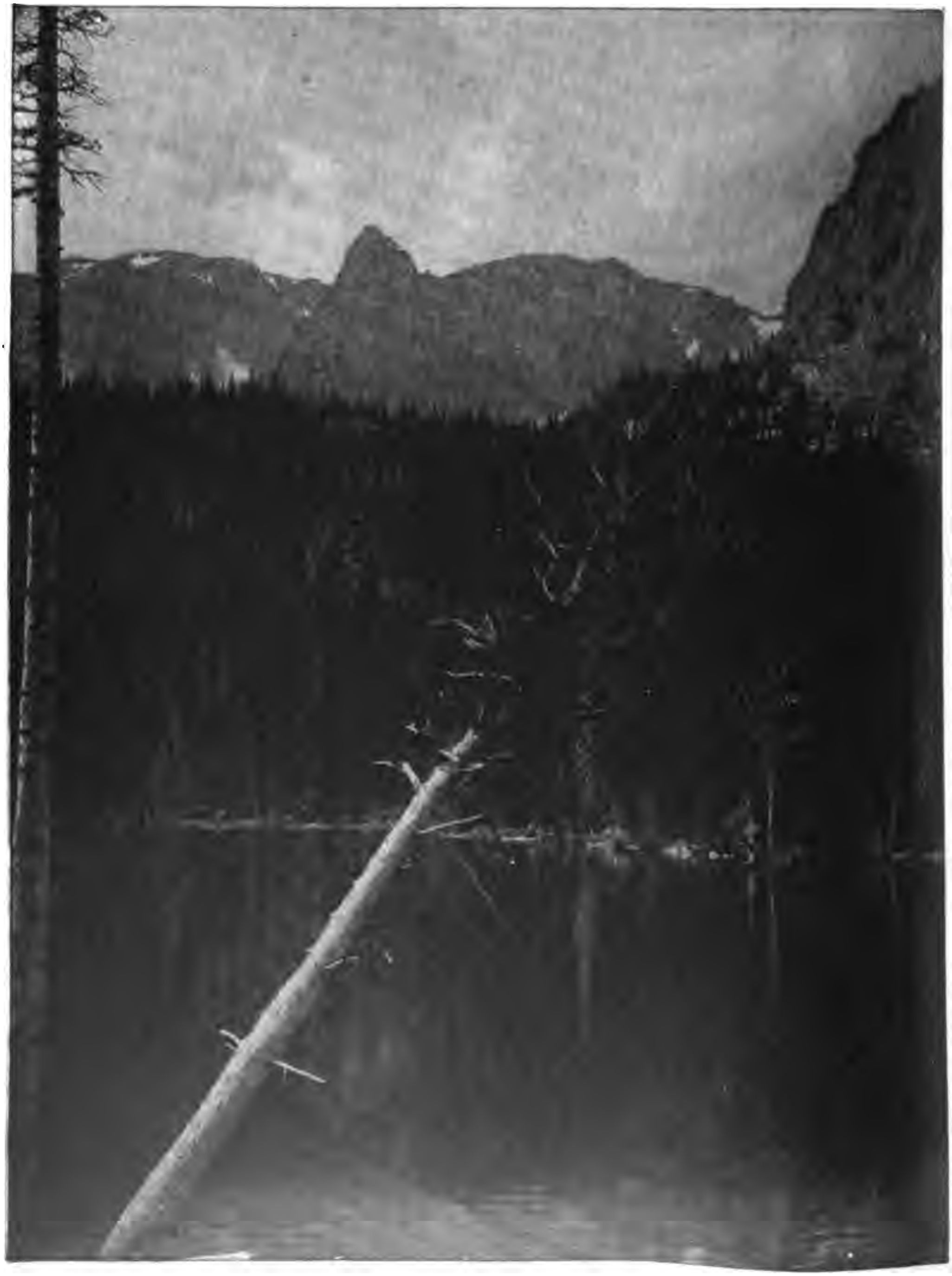
Courtesy National Park Service, Dept. of the Interior.

LOOKING INTO A GREAT CREVASSE.

Courtesy National Park Service, Dept. of the Interior.

THE LAVA PINNACLES OF SAND CREEK.

Scene in Crater Lake Park. Crater Lake is the deepest and bluest lake in the world. In ages gone our Western country was the scene of great volcanic activity. Then the fires died down, water filled the old crater and nature eroded the lava covered surface leaving minarets and domes to tell their story.



Courtesy National Park Service, Dept. of the Interior.

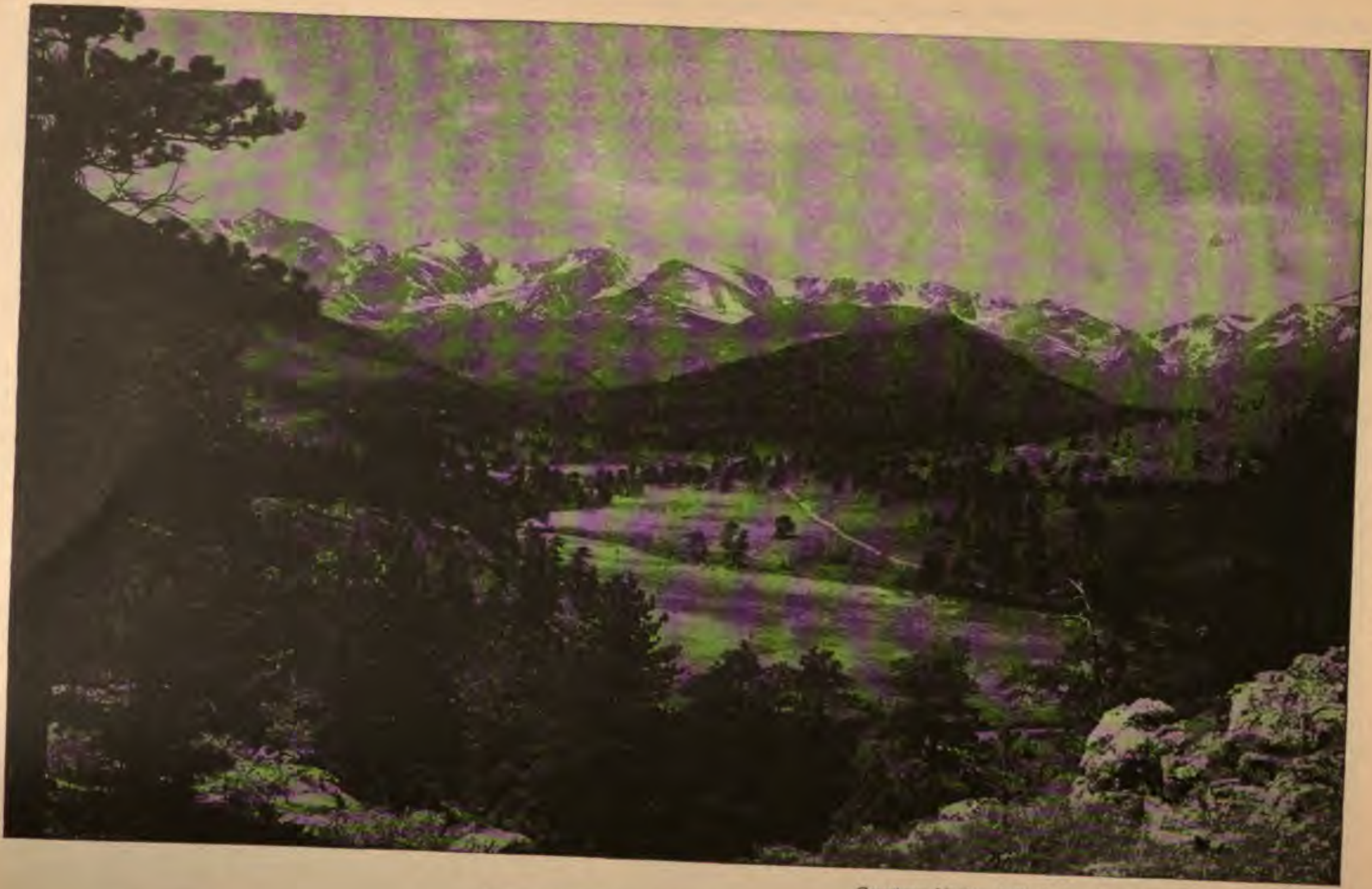
SPRUCE GIRDLED FERN LAKE.

Scene in the Rocky Mountain Park. Singing rivers and shining lakes abound. Frost sculptured granite cliffs assume picturesque shapes; distant peaks hold the wandering clouds in this wonderland of America.

Courtesy National Park Service, Dept. of the Interior.

ON THE PEAKS.

Morning in Mt. Ranier Park. Only craggy heights rise above the fleecy morning mists beneath which the valleys rest, then this scene lights up with the morning sun, the clouds are gone and far off Mt. St. Helena is seen.



Courtesy National Park Service, Dept. of the Interior.

APPROACH TO ROCKY MOUNTAIN PARK.

Notice the snow clad snowy range in the back ground. The valley is 8,000 feet above the sea, but the peaks beyond rise from 12,000 to 14,000 feet additional. The entire park is diversified by grandly moulded mountain masses; and watered by dashing streams and rock bound lakes.

DEPARTMENT OF AGRICULTURE.

The Department of Agriculture was created in 1862 but it was not made an executive department and its head a cabinet officer until 1889. It has in charge the promotion and development of the agricultural interests of the country, regarded as only of minor importance at first, a sort of agency to supply congressmen with seeds to distribute to their clients,—it has become a department of vast importance. We repeatedly heard during the World War that food would win it,—that statement was true and can be extended for it is food that will win the economic war now upon us.

SECRETARY OF AGRICULTURE.

The graphic enables us to visualize the organization of this department. You observe that the secretary has the services of a solicitor who has charge of the legal matters of the department. Also that there is a chief clerk to attend to much detailed work. The assistant secretary has general oversight of the work of the department. There are twenty sub-divisions among whom the duties of the department are apportioned. Only of recent years do we begin to realize the scope and value of the work of these divisions. The names of many tell us the nature of their duties. We will call attention to some of them.

BUREAU OF ANIMAL INDUSTRY.

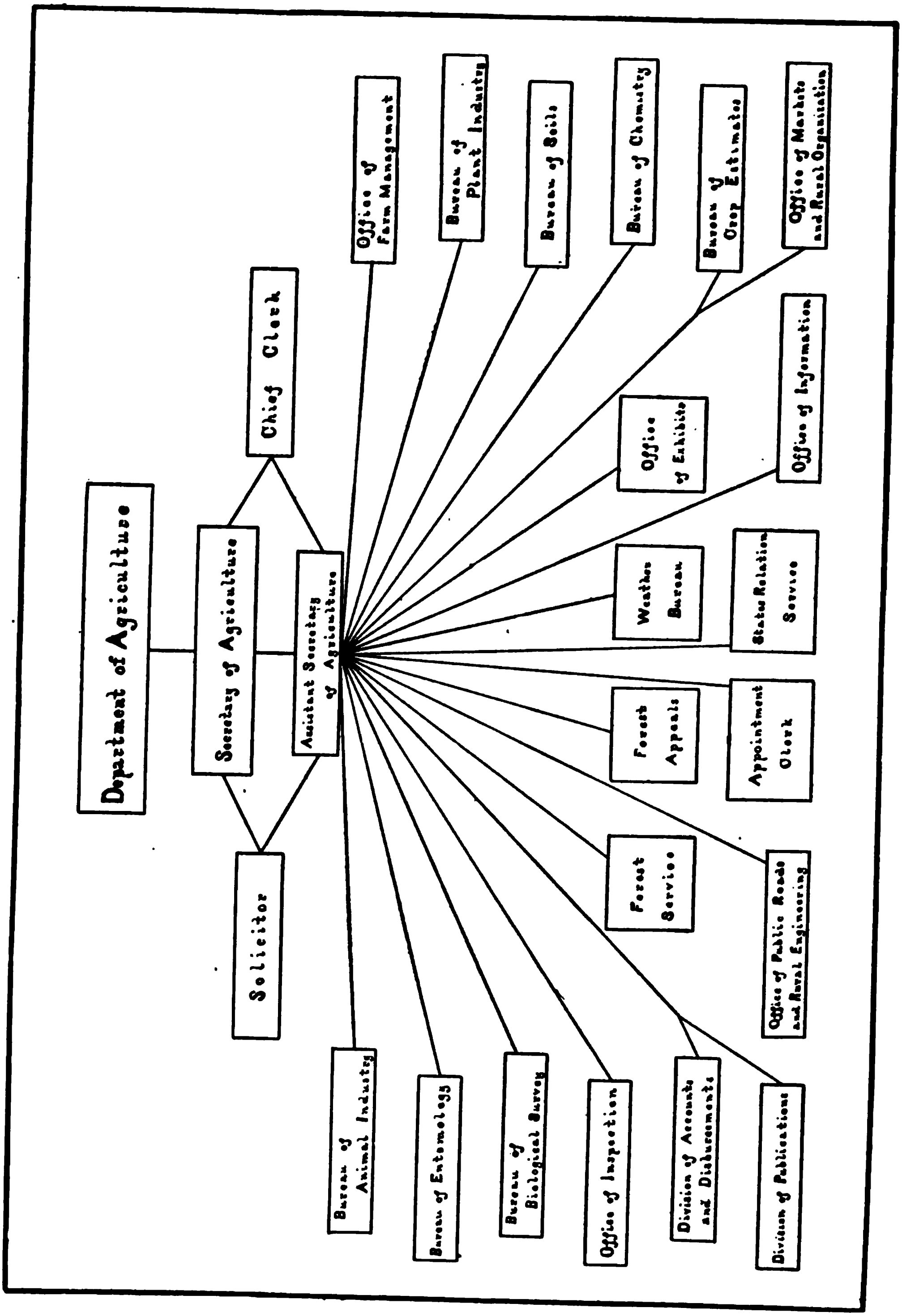
This bureau has oversight of the great livestock industry of our country. We have only to reflect that billions of pounds of packing house produce are needed for home consumption, also to supply the needs of Europe, to realize that the government must have general oversight of the preparation of these products in the interests of public health and to meet the requirements of foreign governments. There are in the United States nearly 1000 establishments where inspectors are stationed to see that conditions are sanitary, and that unfit animals are not used. Of animals of all kinds, nearly 65,000,000 are inspected each year, of that number about half a million are rejected, although the packing houses purchased them in good faith. The general health of the public is thus safeguarded.

TO PROMOTE THE INTERESTS OF LIVE-STOCK PRODUCTION.

That branch of the bureau's activity only concerns finished market product of the live-stock industry. The bureau also is active in all work that promotes the interests of live-stock raisers in all sections of our land. Its experts are at work investigating animal diseases—such as hog cholera—and have perfected numerous serums for use on animals, on exactly the same principle that we vaccinate against smallpox. Some diseases can only be guarded against by stamping them out, such as the foot and mouth disease of cattle. Infected herds are ruthlessly destroyed, large areas of country are quarantined. Every important farm animal—poultry and swine, cattle and horses—is subject to the ravages of specific diseases. Just as human beings are—and it is the business of this bureau to study their diseases and to suggest remedies. It is also its duty to build up this industry for the more farm animals there are, the more eggs, butter, milk, cheese, and meat to supply our needs and the needs of the world.

BOYS AND GIRLS CLUBS.

The department of agriculture must be given the credit of promoting the numerous


Department of Agriculture
Secretary of Agriculture
Assistant Secretary of Agriculture
Chief Clerk
Solicitor
Office of Farm Management
Bureau of Plant Industry
Bureau of Soils
Bureau of Chemistry
Bureau of Crop Estimates
Office of Markets and Rural Organization
Office of Information
Office of Exhibits
Weather Bureau
States Relation Service
Forest Appeals
Appointment Clerk
Forest Service
Office of Public Roads and Rural Engineering
Bureau of Animal Industry
Bureau of Entomology
Bureau of Biological Survey
Office of Inspection
Division of Accounts and Disbursements
Division of Publications

agricultural clubs of boys and girls now enrolling near a million members divided among corn, potatoes, poultry, pig, sheep, calf, and canning clubs, and this bureau is interested in the activities of all the animal clubs just enumerated. The whole club movement is wonderfully stimulating to love of nature, outdoor life, and agriculture generally on the part of boys and girls in rural sections. It enlists their interests in healthful and profitable activities. This aroused interest is in part responsible for the great increase in number of farm animals in recent years. In five years, ending January, 1919, pigs in the United States increased over 16,000,000; while cattle increased nearly 9,000,000.

BUREAU OF PLANT INDUSTRY.

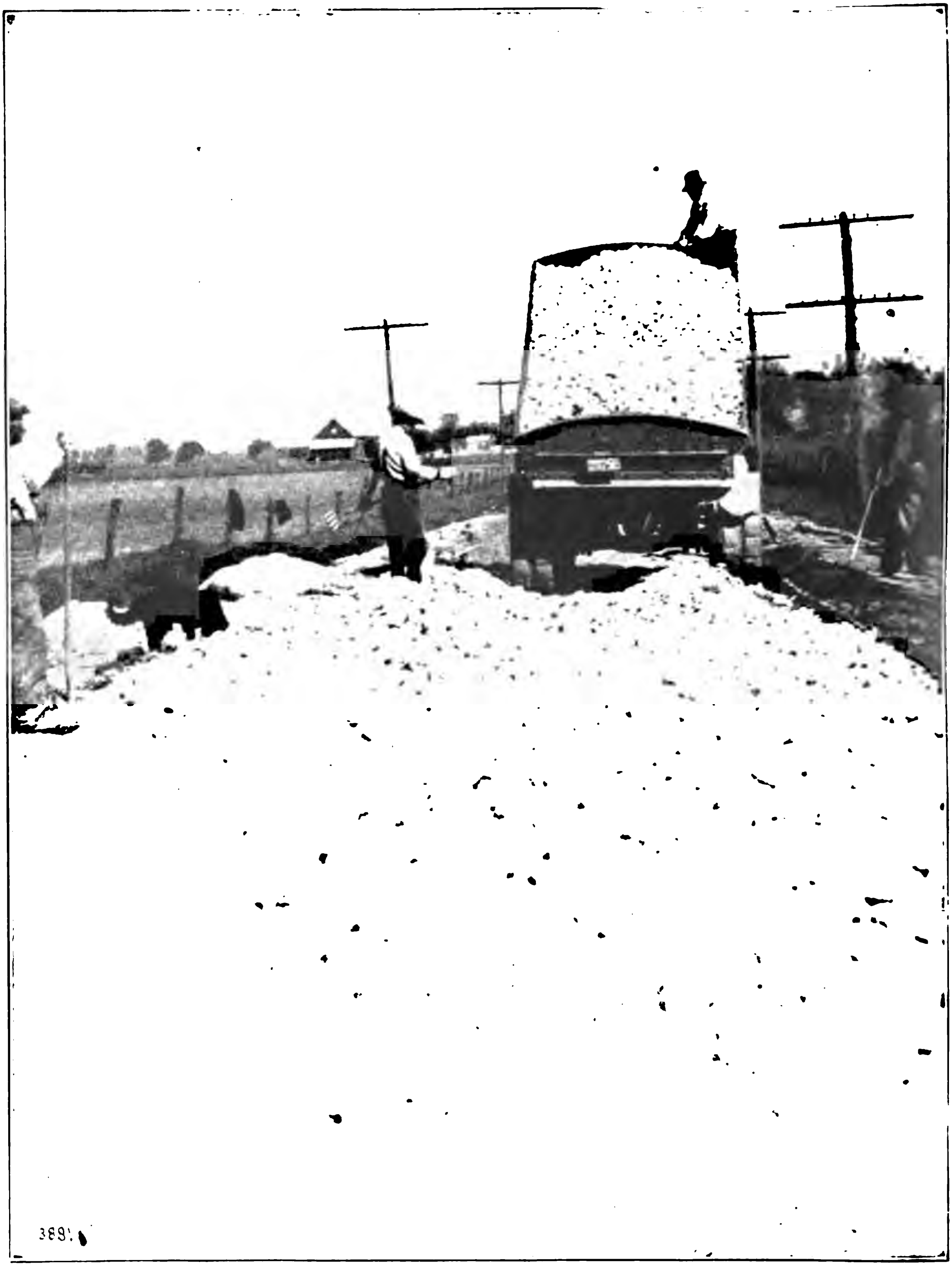
This bureau has in charge the interests of farmers in the growing crops of our country. It seeks the improvement of plants by cultural means, the control of plant diseases, and the introduction of new plants from other parts of the world. The first division—improvement of existing plants—has been considered on a previous page. Its importance has been noticed. A limitless field of such activity is before us. Doubtless all crop products,—grains and grasses, vegetables, fruits and orchard fruits—will continue to be improved until the yield of each crop will be doubled to supply the needs of our increasing population. The bureau of plant industry is active in this matter.

The bureau sends its experts to all parts of the globe searching for new varieties of useful plants that may be introduced into this country and is constantly conducting experiments in this direction. Kaffir corn was thus introduced into arid sections of the West; tea was introduced into the Carolinas; peppers were raised in the South; and dates in California. This bureau also shifts the location of plants already growing in this country. A few years ago, no one thought of raising Egyptian cotton in this country, now many thousand acres of it are growing in Salt River Valley, Arizona, and Imperial Valley, California.

This bureau is engaged in constant research work on plant diseases. All growing crops—all growing animals—are exposed to particular diseases. Our fruit orchards are subject to blight of various kinds; our orange and lemon groves have canker troubles; our truck crops suffer from root-knot; our corn and wheat have smut and rust. Research workers from this bureau are studying all such diseases and endeavoring to find a remedy. Insects injurious to growing crops are the subject of another bureau's activities—the bureau of entomology. Their agents are studying the boll weevil in the South, the alfalfa weevil in the West, and scale insects everywhere. This bureau fights fire with fire and is engaged in the interesting work of importing billions of bacteria that have the useful habit of feeding on other insect forms that are destroying crops as just pointed out. It is impossible to overestimate the value of this bureau to agriculture in our country.

THE BUREAU OF BIOLOGICAL SURVEY.

This bureau is engaged in a study of the food habits of North American birds and mammals in relation to agriculture; it also exercises general supervision of National Mammals and Bird reservations; and attends to the enforcement of the Federal Migratory Bird Act. One branch of activity in this bureau is concerned in killing off predatory wild animals such as wolves, coy-



A SEVEN-TON TRUCK DOING ITS BIT IN ROAD BUILDING otes and mountain lions. A force of several hundred hunters and trappers are employed and some years over 30,000 such animals are destroyed. In case of rodents, it is estimated that in one year $1,000,000 of growing grain were saved in North Dakota by poisoning the ground squirrels in a large section. After reading of this destruction it is interesting to read of efforts the bureau is making to encourage the raising of fur-bearing animals,—such as silver foxes, martens and skunks. It seems that all can be raised with profit.

OTHER BUREAUS OF THIS DEPARTMENT.

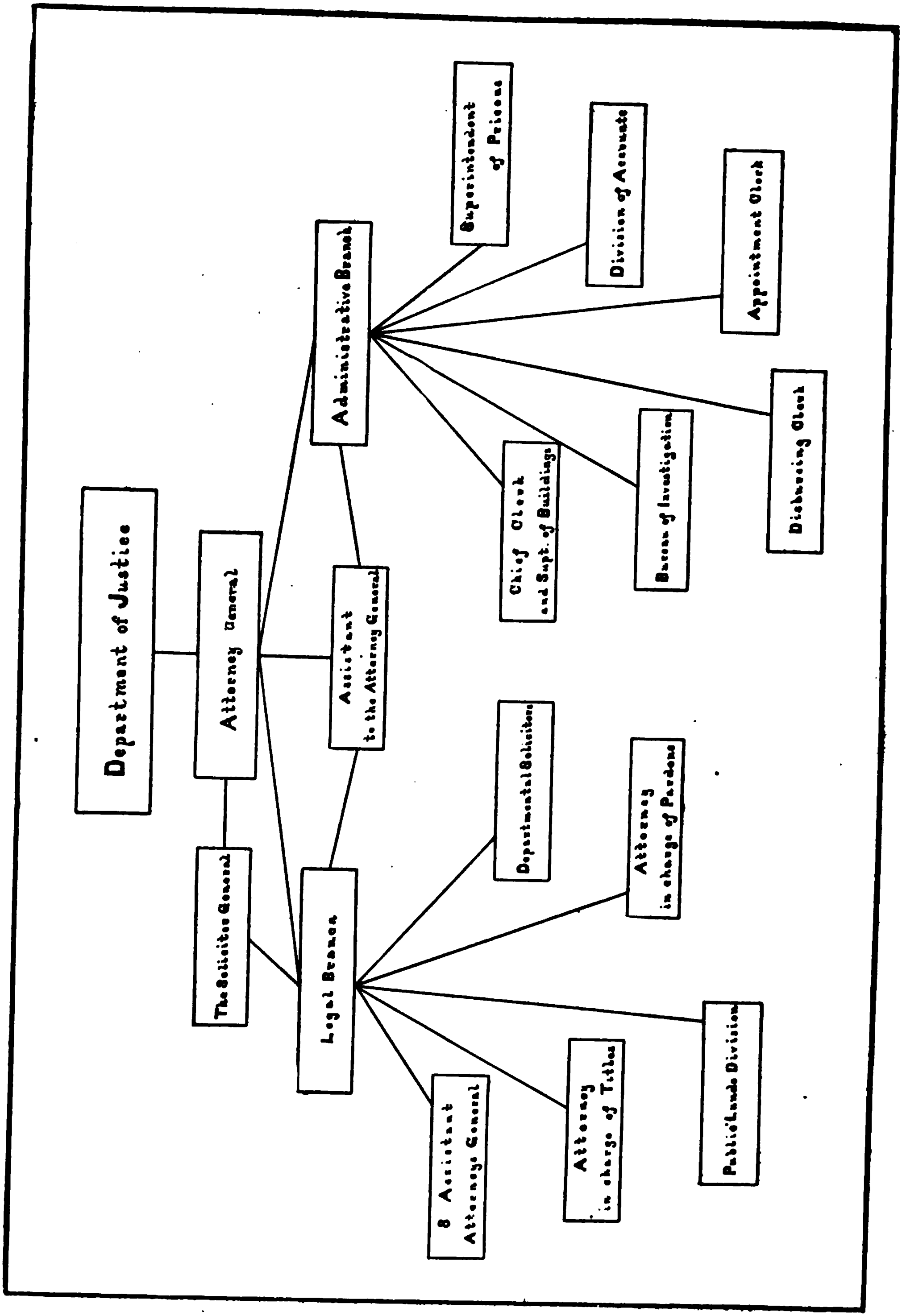
There are other bureaus of great interest and importance. Two of them the Forest Service and the Weather Department are considered on other pages in this volume. The Office of Rural Roads and Rural Engineering, recently instituted, is becoming more important every year, just as our country is waking to the importance of good roads. Nearly every year large sums of money are voted for this purpose by many states. The government appropriated $275,000,000 for the improvement of post roads in the United States, this amount is divided among the states, each state raising an amount equal to what it receives for that purpose; approximately $700,000,000 in all are being expended on road improvement. All projects that receive money from the United States are under the oversight of this office. The importance of good roads is evident if we will refer to the use of auto trucks, as rural express and freight carriers.

STATES RELATION SERVICE.

The United States government made generous grants of government land in 1862 to the several states to endow agricultural colleges in the states. In most cases these land grant colleges have become state universities, as the University of Illinois. In 1887 congress authorized the institution of experiment stations in connection with the state schools. Finally in 1914 the States Relation Service was organized to have general charge of the department business with the state schools and experiment stations, and to provide for a nation-wide system of instruction for the farming population in Agriculture and Home Economics,—along the lines of County Agricultural Agents, Boys and Girls clubs, Movable Schools, and Expert Instruction from college and department specialists.

THE DEPARTMENT AS A WHOLE.

We can not properly estimate the importance of the work of this department unless we bear in mind the importance of agriculture in our country. We are now a nation of considerable more than 100,000,000 people and we are increasing in population. Every year we need greater supplies of food, but our area is limited. We must not only reclaim some of our arid sections; but, what is more important, increase the yield of our orchards, forests and farms. That is the purpose of this department. The Bureau of Soils and the Bureau of Chemistry is considering how to increase the fertility of our soils. The Division of Publication is sending to the farmers thousands of bulletins setting forth improved methods of procedure. The Office of Farm Management is considering how to conduct farm work most efficiently. The Office of Markets and Rural Organization is studying means of distributions, so that vegetables and fruits will not be left to decay for lack of distribution to hungry people in near-by cities.


Department of Justice
Attorney General
Assistant to the Attorney General
Administrative Branch
Superintendent of Prisons
Division of Accounts
Appointment Clerk
Disbursing Clerk
Bureau of Investigation
Chief Clerk and Supt. of Buildings
The Solicitor General
Legal Branch
Departmental Solicitors
Attorney in charge of Pardons
Public Lands Division
Attorney in charge of Titles
8 Assistant Attorneys General

DEPARTMENT OF JUSTICE.

The Department of Justice must not be confounded with the judicial branch of the government that was considered under the head of the "Government of the United States." The department of justice is entirely the creation of congress. It is an executive department designed to assist the president by attending to the legal business that necessarily accompanies the executive branch of the government. Congress may pass certain measures, the president is in duty bound to see that they are carried out, but legal questions are sure to arise, and it is the duty of this executive department to assist the president in this feature of his work. It is not for this department to pass on the constitutionality of a law, that is solely the province of the supreme court. The department might, however, be very active in bringing a law which is questioned before the supreme court for its opinion.

THE ATTORNEY-GENERAL.

The Attorney-General is, as shown on the graphic, the official head of this department; as such he is a member of the president's cabinet. He is the chief legal officer of the country. He gives his advice and his opinions when consulted by the president or the heads of the departments. Opinions on constitutional questions must come from him, but opinions on other matters may be given by his assistants. Trials in which the government is interested may be conducted by the attorney-general or the solicitor-general who acts as his assistant and assumes his duties in his absence. This fact could be deduced from the graphic.

ASSISTANT TO THE ATTORNEY-GENERAL.

From the graphic we may notice the further fact that the attorney-general has a special assistant. This officer has special charge of matters arising out of the anti-trust legislation. As indicative of the growth of business in this department, we might say that anti-trust suits increased from seven cases in Harrison's administration to eighty-nine cases in Taft's administration. The inter-state commerce suits illustrate how little the framers of the constitution could foresee the effect of certain clauses of the constitution. The constitution asserts that congress shall have power to "regulate commerce among the several states." Those few words are the foundation on which rests an enormous mass of legislation, and of a most important character. It requires a special commission and a special court to supervise the execution of those laws, and, as we now see, the services of a special assistant attorney-general. The volume of interstate commerce is so enormous, and it so vitally affects the welfare of the people of the entire country, and branches in so many different ways that many special attorneys are engaged to assist in the work of this office.

THE LEGAL BRANCH.

Further study of the graphic discloses that the vast business of the department is divided into two branches. The organization of the legal branch is set forth on the left-hand half of the graphic. The immense amount of detail necessarily connected with the three offices thus far considered is attended to in the sub-offices of the legal branch. Notice, first of all, there are eight assistant attorney-generals, some having charge of special lines of business, as defense of cases in the court of claims which is a part of the judicial branch of government (see graphic United States Government), and the work of all the district attorneys throughout the United States. There is a special assistant who has charge of the bureau of insular affairs (see War Department graphic). In studying other departments you noticed solicitors for the department. Such solicitors are under the general charge of this branch of the judicial department. They act as chief law officers of the department to which they are accredited. Other attorneys are noticed having charge of special branches of legal business, as titles (to property), pardons, and public lands.

ADMINISTRATIVE BRANCH.

As its name indicates, the administrative branch of the department's business is concerned with details other than those of a strictly legal nature. The names of the various sub-officers indicate the nature of their work. The superintendent of prisons has general oversight of all federal penitentiaries and all federal prisoners wherever confined. The division of accounts examines the accounts of the United States district attorneys and marshals.

Like other executive departments of our government the activities of the department of justice were greatly increased during the World War. Such increase was occasioned by violation of the neutrality laws, Trading with the Enemy Acts, and the Espionage Law. The Alien Property law necessitated a great deal of work. While a large part of this extra work is no longer necessary, the mere growth of our country in population, trade, and wealth will result in an ever growing volume of legal business which can be attended to only by this department.

WAR DEPARTMENT.

The Department of War is the executive branch of government that has in charge military activities of our country, always of great importance, in times of war it easily becomes the most important of all. All other business is then subsidiary to the one business of war. During the anxious months of the World War the necessary work of this department suddenly increased many fold.

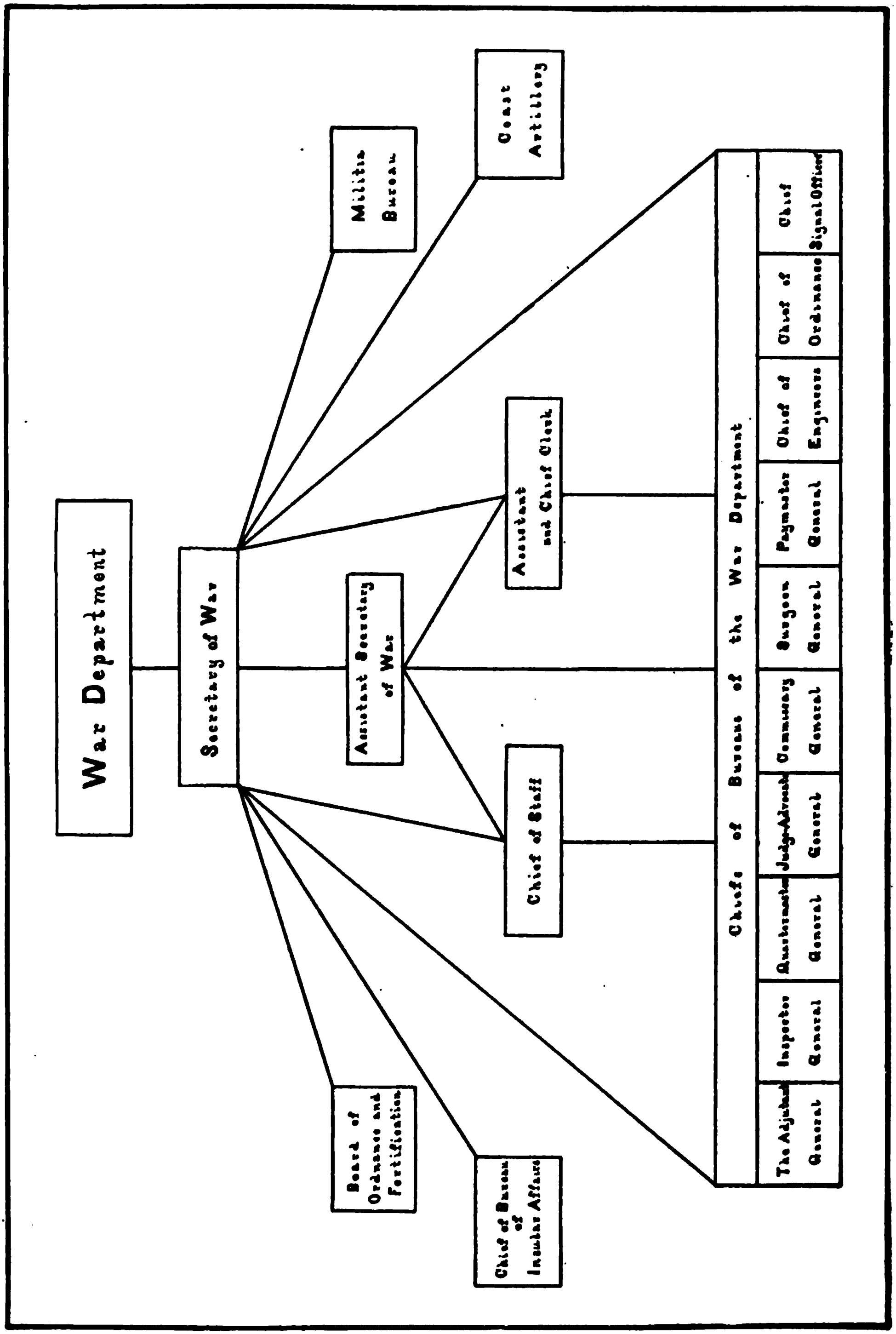
At its head is the Secretary of War. This official is not usually one trained in military matters and but few generals have ever served in such a capacity. Generals Grant and Sherman were two notable exceptions. As chief executive of the United States the president is commander-in-chief of the army and navy, the secretary of war is the official who attends for the president to the vast amount of executive business pertaining to war.

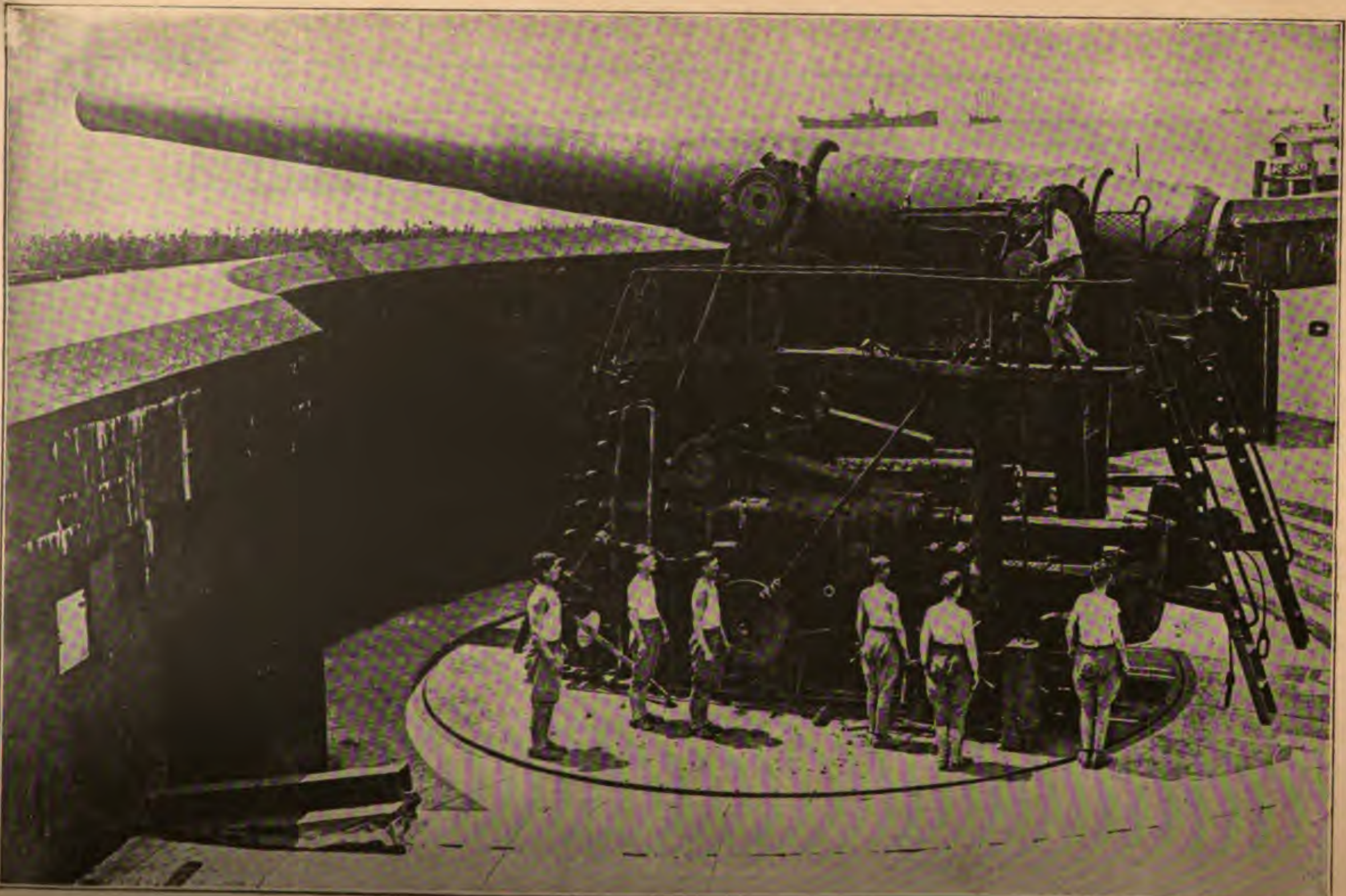
ORGANIZATION OF THE DEPARTMENT.

The graphic showing the organization of the department should be studied with some care. In administering the affairs of the department the secretary is aided first, by the assistant secretary, who exercises direct supervision only over those matters which do not determine or affect the policy of the department and which will not serve to establish a precedent.

THE WAR DEPARTMENT BUREAUS.

Notice the ten bureaus represented in the lower line of the graphic. The officials in charge of the bureaus are all officers of the regular army of the United States. Each bureau has a distinct and important part of work connected with the army and all must function harmoniously if the army is to do efficient work. Their names are indicative of the work they do. Notice the way in which they are related to the secretary's office. The heads of all these bureaus assist the secretary in the discharge of his duties.


War Department
Secretary of War
Militia Bureau
Coast Artillery
Assistant Secretary of War
Assistant and Chief Clerk
Chief of Staff
Board of Ordnance and Fortification
Chief of Bureau of Insular Affairs
Chiefs of Bureaus of the War Department
The Adjutant General
Inspector General
Quartermaster General
Judge-Advocate General
Commissary General
Surgeon General
Paymaster General
Chief of Engineers
Chief of Ordnance
Chief Signal Officer



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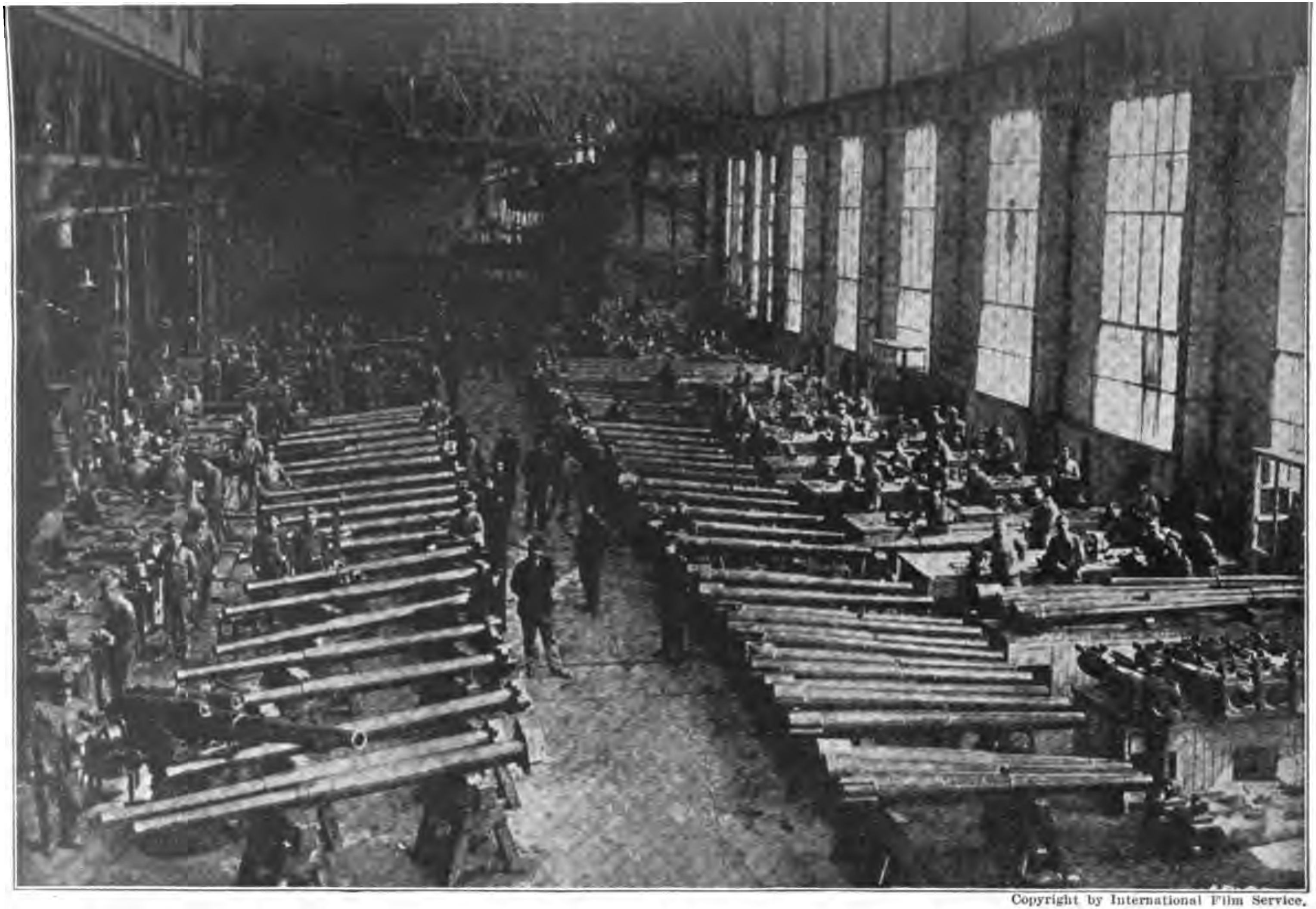
A TWELVE-INCH DISAPPEARING GUN.

Used to defend our seaport cities. At important points, 16-inch guns are placed. The gun is represented in its firing position. The recoil will send it back nearly horizontally, when its muzzle will clear the parapet, machinery automatically lowers it to its base. In that position, it will be loaded, aimed and automatically raised to its firing position. A 16-inch gun throws a shell weighing 2,400 pounds a maximum distance of 27 miles; at its greatest height, that shell is eight miles above the surface. No ship afloat could withstand the effect of such a shell falling that distance, filled with high explosives, if it landed on its deck.



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INTERIOR OF AN ARSENAL.

In this country the Bureau of Ordnance of the War Department has charge of our arsenals, one of the most important of which is located at Rock Island, Illinois. Making heavy guns is a very interesting and highly scientific process. The core of the gun is a huge ingot of specially prepared steel of the highest quality, tested every step of the way. The forging, annealing, and boring of the gun is according to scientific formula. The barrel is then built up or wound with wire to further strengthen it.

We can readily understand that the work of each bureau rapidly increased many fold during the world war. The ordnance bureau, before we had been in the war six months, was expending each four hours of the day what, prior to the war, it expended in a whole year. A similar increase was noticed in the quartermaster's bureau; while in the chief signal officer's bureau the immense development of aircraft production made it one of the most important bureaus of army administration; and such it will continue to be in the future. There is no solicitor connected with this department, the duties of such an official being discharged by the judge-advocate general.

GENERAL STAFF.

The General Staff was organized by congress to better co-ordinate the work of the various bureaus that we have briefly noted, the lack of such co-ordination being a serious defect in our army organization. The formation of such a staff was a belated recognition and adoption of the wonderfully efficient staff organization of the French and German armies. It consists of a chief of staff who takes the place of the commanding general of the army; two general officers detailed by the president, not below the grade of brigadier general, and forty-two officers of a minor grade—but not below the rank of captain—also detailed by the president. It is the duty of the general staff to prepare plans for the national defense, and for the mobilization of the military forces in times of war; to assist the secretary of war to increase the efficiency of the military establishment; and in case of war to act as a board of strategy. The chief of staff is the military adviser of the secretary of war and has supervision of all troops of the line. And with the secretary—under the direction of the president—exercises supervision of the ten administrative bureaus shown on the lower line of the graphic. The war college was a school organized to train minor officers—selected from the general staff service.

BOARD OF ORDNANCE AND FORTIFICATION ACTIVITY.

On the graphic we notice four departments of military activity under the direct supervision of the secretary of war,—Board of Ordnance and Fortification, Bureau of Insular affairs, Militia Bureau, and Coast Artillery. What we have thus far considered are bureaus connected with the administrative side of the war department.

There are two main channels through which is received what is necessary for the prosecution of a war. The quartermaster general subsists and attends to the material wants of the soldier; the chief of ordnance furnishes him with the powder and ball, the guns and military equipment he fights with, and puts in his hand what he needs in prosecuting the business for which he is sustained. Arsenals, armories, munition factories—when taken over for government use—fall under the administration of the ordnance department. This bureau contracts for the manufacture of arms, large and small, horse equipment, gun mounts, etc., and in times of war exercises powers of great magnitude.

COAST ARTILLERY.

The Coast Artillery is for defensive purposes. Nearly all the coast artillery guns are fixed in position, but it is intended to make some of them mobile so that they can be shifted as needed to unfortified harbors and beaches. For defensive purposes, the shore line of the United States is divided into three districts. The North Atlantic, extending from Maine to Sandy Hook; the South Atlantic, from Delaware Bay to Texas; and the Pacific, from San Diego to Puget Sound. There are forts also in the Philippines, in Hawaii, and in Canal Zone. This Branch of the service calls for about 30,000 men.

The Bureau of Insular Affairs is charged with the administration of all matters of civil government in the island possessions of the United States under the jurisdiction of the war department.

NAVY DEPARTMENT.

The law authorizing the Navy Department sets forth that "The secretary of the navy shall execute such orders as he shall receive from the president relative to the procurement of naval stores and material and the construction, armament, equipment and employment of vessels of war as well as all other matters connected with the naval establishment." From that authorization has developed our present navy department that experienced during the world war a sudden and vast development and is now steadily becoming of increasing importance in keeping with our commanding position as one of the great powers of the world, our navy being now second to that of Great Britain and it is the present policy of our government to enlarge it. We note that the secretary is advised by his solicitor. This official is an assistant attorney-general of the United States. Questions of international law are constantly arising, for our navy commanders are frequently dispatched on more or less diplomatic missions. As a further consequence this department is in close relations with the state department.

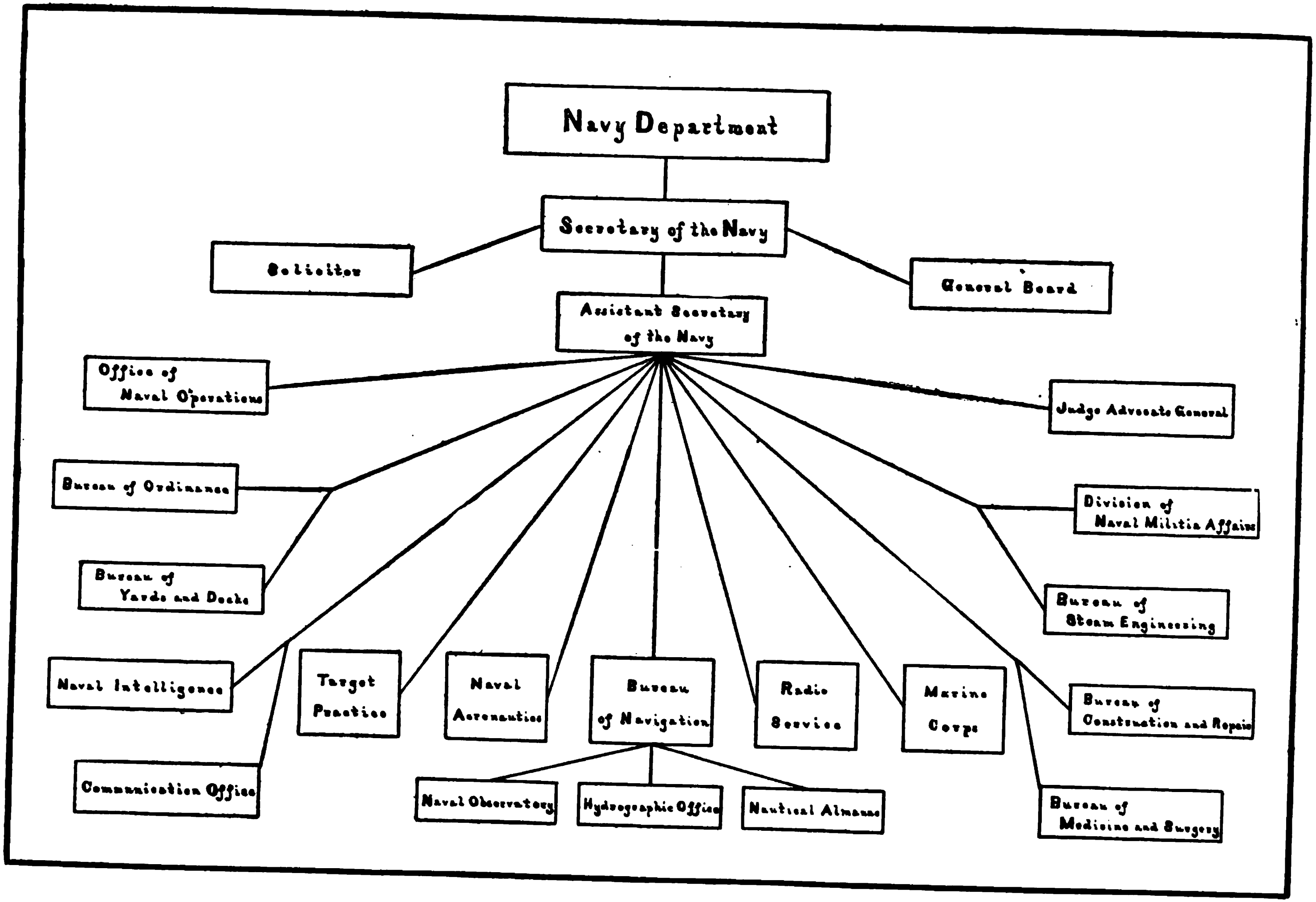
ORGANIZATION OF THE DEPARTMENT.

The organization of the department is shown on the graphic. The office of the assistant secretary was established in 1890. It is designed to relieve the secretary from detail work. The details are carried out by eight bureaus with their divisions. The bureau heads are naval officers appointed by the president from certain naval grades prescribed by law. While acting as such heads they have, actually or nominally, the rank of rear admiral. The names of the various bureaus are indicative of the nature of the duties they attend to. We can readily understand that during the World War the work of the entire department, and so of each bureau, was greatly enlarged.

THE GENERAL BOARD.

The General Board acts as an advisory council to the navy department. It is composed of naval officers of various grades and advises the secretary on technical matters, and submits plans for naval maneuvers and questions of naval strategy. During the stress of the World War the heads of the various bureaus formed the secretary's cabinet and was called the Advisory Council. Another emergency board was the Naval Consulting Board. It was composed of members selected by the leading scientific societies of the United States. It was concerned with research work, investigating and testing proposed inventions, in a special sense devices for overcoming submarines. In one year nearly one thousand models designed to accomplish that purpose were tested. Listening devices with which submarine chasers are provided is an instance of a successful invention.

This organization of the department was so efficient that it bore the strain of actual


Navy Department
Secretary of the Navy
Solicitor
General Board
Assistant Secretary of the Navy
Office of Naval Operations
Judge Advocate General
Bureau of Ordinance
Division of Naval Militia Affairs
Bureau of Yards and Docks
Bureau of Steam Engineering
Naval Intelligence
Target Practice
Naval Aeronautics
Bureau of Navigation
Radio Service
Marine Corps
Bureau of Construction and Repair
Communication Office
Naval Observatory
Hydrographic Office
Nautical Almanac
Bureau of Medicine and Surgery

war in a very satisfactory manner. We must reflect that our navy personnel increased during the war from less than 66,000 men to more than 497,000; the number of ships in commission increased from 197 to 2,003. Before the war the greatest amount spent for naval supplies in any one year was $27,000,000. We were spending more than that day after day for supplies when the war ended. Yet all that was necessary was to increase the working force of the organization already perfected to care for this increased business.

THE NAVAL OBSERVATORY.

This is a division of the Bureau of Equipment. Its duties are to determine accurately the positions of the sun, moon, planets and the earth for use in navigation; to test chronometers for use on naval vessels; to issue correct time daily; to prepare and issue to naval vessels instruments of precision to aid in navigation,—sextants, compasses, etc.; to conduct astronomical investigations of general and special scientific interest; and to publish the nautical almanac. This observatory takes rank with those at Greenwich and Paris. Among the scientific discoveries of interest made at the naval observatory was that of the moons of Mars in 1877.

All this is a very important part of naval department work. The navigators of our naval vessels—some of which cost well into to millions of dollars—must have all the scientific aids to navigation possible. The time must be known, or they cannot calculate their position on the ocean. To enable them to know the time, the naval observatory sends out twice daily—at noon and at 10 p. m.—the time according to their standard clock that is regulated to the one hundredth part of a second by observation taken on the transit of stars. The time signals are sent out over telegraph wire to every important city in the land, but also by wireless from Radio, Va., to every naval vessel on the Atlantic, and from Mare Island, Cal., to naval vessels on the Pacific. What a wonderful accomplishment this is—no matter where they be, our naval vessels get the time signals from Washington. This service is not confined to naval vessels, however.

THE NAVY THAT FLIES.

Notice the devision of Naval Aeronautics. This was organized to meet the needs of the world war—but it has come to stay since sea-planes and flying boats are essential to a modern navy. During the war naval air stations were located at all strategic and important points on the coast of the United States, one was located in the Canal Zone, so that our vessels on the Atlantic were constantly under the eye of naval fliers. Stations in Ireland, England and France were also operated by them. In the summer of 1918 a total force of 30,000 men formed the personnel of our navy that flies. Permanent buildings, factories, hangars, etc., have been erected at the Philadelphia naval station.

NAVAL COMMUNICATION SERVICE.

This office has charge of the government radio service and of all telegraph, telephone, and cable communications connected with the naval service. There is an extensive radio system operated from various stations on the coast in order to control the movements of the fleet, and the department is connected at all times with its navy yards and stations, by telegraph, cable, and radio. The immense radio stations found here and there in the United States, in the Canal Zone, Hawaii, Alaska, Guam,—are all under the control of the navy department. It was this department that tested the underground wireless system, and it has done much to develop wireless telephony. It also has tested and approved wireless controlled torpedoes of which mention has been made.

THE MARINE CORPS.

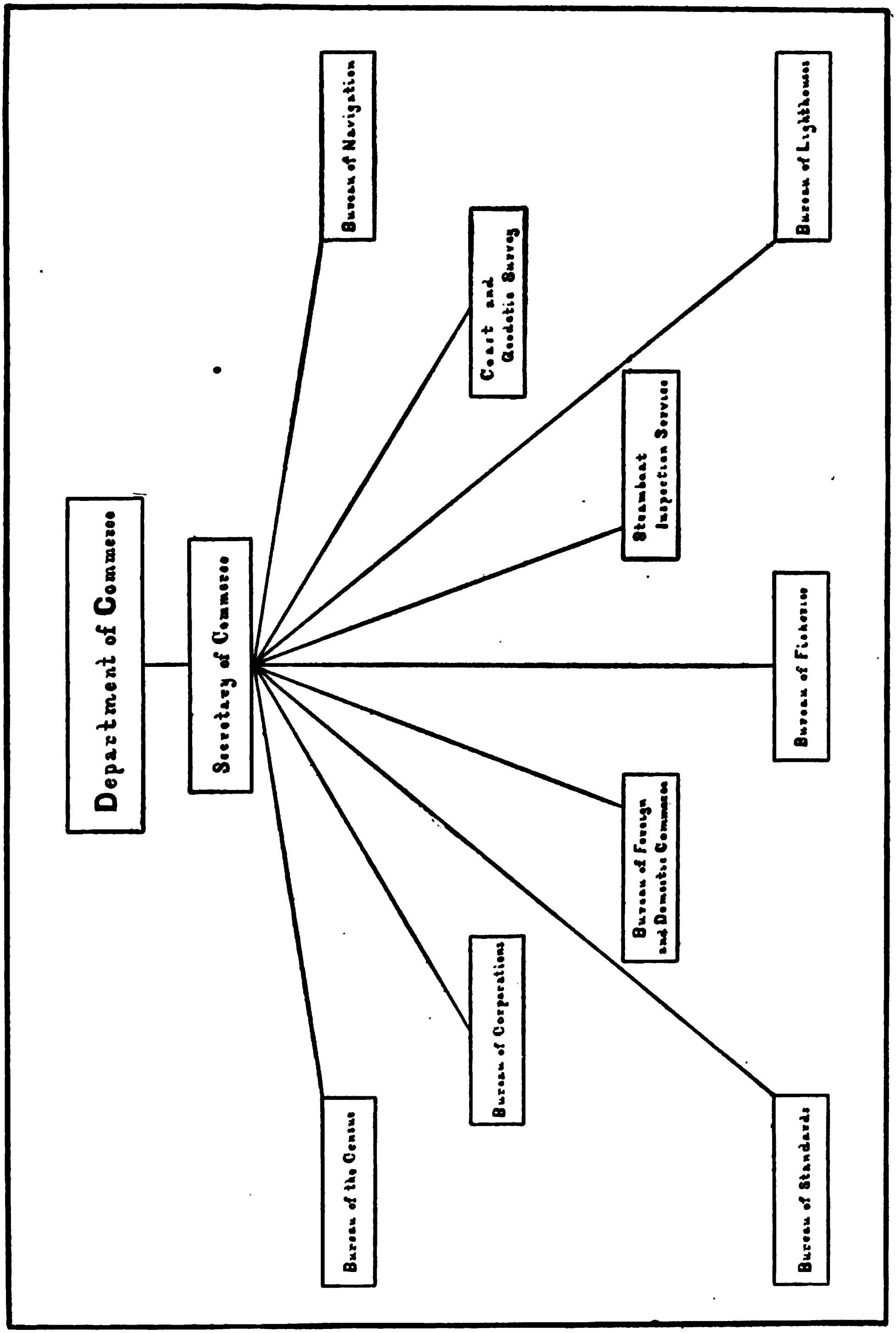
It is not out of place to call especial attention to the Marine Corps. This is an independent branch of the military service of the United States, serving generally under the direction of the secretary of the navy. They normally do garrison duty at navy yards, and naval stations. They are landed in foreign countries to protect American interests, or whenever we assume charge of affairs in foreign lands, as in Haiti and San Domingo. They may, however, be detached for army service by command of the president. The American people will ever remember the gallant action of our marine corps in the great World War. To them is due the victory at Chateau Thierry and Belleau Woods. These battles were among the most critical of the war; defeat at Chateau Thierry very likely would have been followed by the fall of Paris.

THE BUREAUS IN GENERAL.

The bureau of navigation attends to the promulgation and enforcement of the secretary's orders, also the education of officers and so has charge of the military academy. The bureau of yards and docks has general supervision of all navy yards of which there are nine. These stations are provided with facilities for the construction and repair of ships, and supplies for the same. The bureau of equipment furnishes all supplies to ships. The bureaus of ordnance, of construction and repair, and of steam engineering, arm vessels, plan, construct and build them, and install machinery. The bureau of medicine and surgery attends to the medical needs, has charge of hospitals and medical supplies. The bureau of supplies and accounts is the bookkeeping department and the general paymaster of the navy is its chief.

DEPARTMENT OF COMMERCE.

The Department of Commerce is composed of unrelated bureaus and branches of the public service; but all are found to concern the commercial activity of our country. It is one of the latest executive departments of our government being instituted in 1913. Commerce—the exchange of commodities—is to the health and prosperity of a nation as the ciculation of blood is to the physical well being of individuals. Just as the blood is the current that brings to all the tissues and organs of the body needed supplies to renew worn out parts; so commerce brings to every part of our national domain supplies to renew the needs of social life. Hence, it is that in process of time an executive department of government was organized and charged with general oversight of various organized activities of government loosely related to United States commerce. There are nine bureaus in this department. Each one possesses great possibilities. In days to come, in the strenuous new age, when nation shall vie with nation for world trade these possibilities will be recognized. The trade of the United States—foreign and domestic—is far larger than that of any other nation. Owing to our great industrial strength, our unrivaled resources, our large and growing population, our wonderfully efficient transportation system, our leadership in finance, this trade will certainly grow with great rapidity. Every detail connected with the same is thus invested with great interest to us.


Department of Commerce
Secretary of Commerce
Bureau of Navigation
Coast and Geodetic Survey
Bureau of Lighthouses
Steamboat Inspection Service
Bureau of Fisheries
Bureau of Foreign and Domestic Commerce
Bureau of Standards
Bureau of Corporations
Bureau of the Census

BUREAU OF STANDARDS.

This bureau is charged with the examination of all manner of standards of measurements, of quality, and of mechanical performances and practice, to see that they conform to the official standards at Washington, which are in the custody of the bureau. The bureau is charged also with the solution of problems concerning standards, either for the government, a state, a city, or any society, institution, or firm in the United States, although it charges a fee for such service, except that rendered to the government or to any state. It serves as a testing bureau for all government departments at Washington. Its work is divided into examinations of standards falling under the following divisions; 1, weights and measures; 2, heat and thermometry; 3, electricity; 4, light and optical instruments; 5, chemistry; 6, engineering, research and testing; 7, metallurgy; 8, miscellaneous materials. The most wonderful scientific instruments of precision in the world are located in this bureau. Scales so delicate that a hair is readily weighed; thermometers so sensitive that the heat radiated from a person a few feet away is shown; and on the other hand, machines so strong that they will tear a sheet of steel as easily as you could this sheet of paper. But exact standards of measurement are necessary in commerce.

BUREAU OF FOREIGN AND DOMESTIC COMMERCE.

This bureau was organized in 1912, combining the activities and functions of the Bureau of Statistics and the Bureau of Manufactures. It is charged with the encouragement and development of United States manufacturing interests both at home and abroad. It collects, supervises, and distributes reports from the ten commercial attaches and nineteen commercial agents of the department, as well as the trade reports of the United Statees consuls. It provides general statistical information which will enable American manufacturers and merchants to invest capital abroad with the most beneficial results. It also issues authentic statistics of exports, and reports on the costs of production in various industries. The bureau's reports and criticisms of commercial conditions aim to be constructive so well as informing, and for this purpose it has divided the country into commercial districts, over each of which presides an officer of the bureau.

BUREAU OF CORPORATIONS.

This bureau is one of the most important divisions of the department. It has authority to make investigations into the organization, conduct, and management of business of any corporation, joint stock company, or corporate combination (except common carriers) engaged in commerce among the several states and with foreign nations and has the same power in respect to these as is conferred upon the interstate commerce commission.

It will be noticed that common carriers are not subject to review by this bureau. By the interstate commerce act they are placed under the jurisdiction of the interstate commerce commission. It will be noted that by means of the bureau of corporation and the interstate commerce commission the general government exercises great control over internal commerce in the United States. But, notice, the general government cannot exert control over business confined to the bounds of one state. Each state is independent within its own territory, it is only when the business extends to include several states that the United States gains control.

BUREAU OF FISHERIES.

Few people rightly comprehend the immense fishery industry of the United States. This industry is capable of vast development. Nearly 10,000 vessels are engaged in the work; nearly 200,000 people are employed; about $100,000,000 of capital is invested, and the value of yearly products is about the same amount. Yet the industry in Alaska is in its infancy. It is the duty of this bureau to investigate all conditions surrounding the propagation of the useful fishes—their breeding grounds; restocking of rivers and lakes with edible fishes; and collecting statistics concerning the fishing industry. This bureau also has jurisdiction over the fur seal herds of Alaska. Only the care extended to these herds by this bureau prevented their extermination.

THE CENSUS BUREAU.

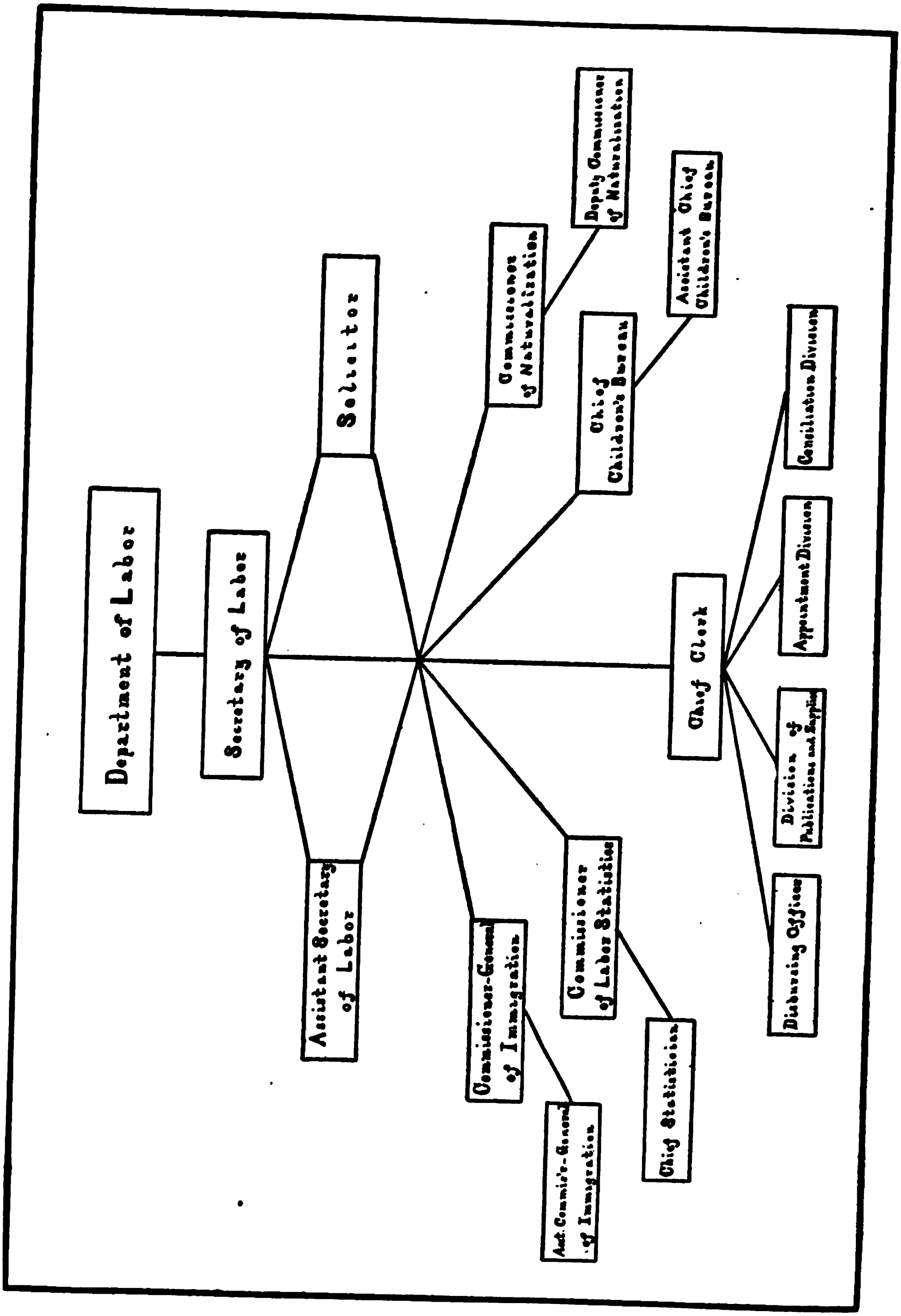
The work of the census bureau is divided into two main branches. The first is the great census taken every tenth year. That to be taken in 1920 will be the fourteenth census. The work of the bureau at such times is very extensive and thorough, requiring the assistance of many thousand enumerators. It will cover three main subjects—population, agriculture, and manufacturing industry; and doubtless many other subsidiary lines having to do with the internal affairs of the United States. As we know the number of representatives in congress to which a state is entitled is determined from the results of the census enumeration. In addition to the main census, the bureau is engaged in statistical work relating to trade, and agriculture; there is for instance a census of manufacturers and agriculture in the fifth year intervening between two census years. Estimates of population are published every two years, etc.

WORK OF OTHER BUREAUS.

Notice the bureau of Navigation, as we have seen, there is a bureau of this same name in the navy department. This commerce bureau superintends conditions surrounding the commercial marine and merchant seamen of the United States over whom jurisdiction is not definitely assigned to some other authority. Notice, also, the coast and geodetic survey, and distinguish between the work of that bureau and that of the geological survey in the interior department. This commerce bureau is charged with the survey of the coasts of the United States, gathering data of value to marine commerce. The bureau of lighthouses is charged with the establishment and maintenance of light-houses, light-vessels, buoys and other aids to navigation on the coasts and rivers of the United States. The steamboat inspection service is charged with the inspection of all vessels flying the United States flag which are not directly connected with the navy department.

DEPARTMENT OF LABOR.

The Department of Labor is one of our latest organized executive departments, being created in 1913. The secretary is charged with the duty of fostering, promoting and developing the welfare of the wage-earners of the United States, improving their working conditions, and advancing their opportunities for profitable employment. He has power under the law to act as mediator and to appoint commissioners of conciliation in labor dispute whenever in his judgment the interests of industrial peace may require it


Department of Labor
Secretary of Labor
Solicitor
Assistant Secretary of Labor
Commissioner of Naturalization
Deputy Commissioner of Naturalization
Chief Children's Bureau
Assistant Chief Children's Bureau
Commissioner-General of Immigration
Asst. Commis'r-General of Immigration
Commissioner of Labor Statistics
Chief Statistician
Chief Clerk
Conciliation Division
Appointment Division
Division of Publications and Supplies
Disbursing Officer

to be done. Many of the bureaus of the present department existed as bureaus or commissions in other departments, but the growing importance and increasing strength of labor organizations and trade unions led to their being placed in a department by themselves so that their activities could be better focused to one end—the improvement of labor.

ORGANIZATION OF THE DEPARTMENT.

From the graphic we can see the organization of this department for business. Observe the secretary has an assistant, a chief clerk who attends to the details of the administration duties of the department, and a solicitor who is under the general jurisdiction of the department of justice. Notice, also, the offices among whom the work of the chief clerk is divided. The great special features of the department work are shown under the direct supervision of the secretary and his assistant on the sides of the graphic.

IMMIGRATION.

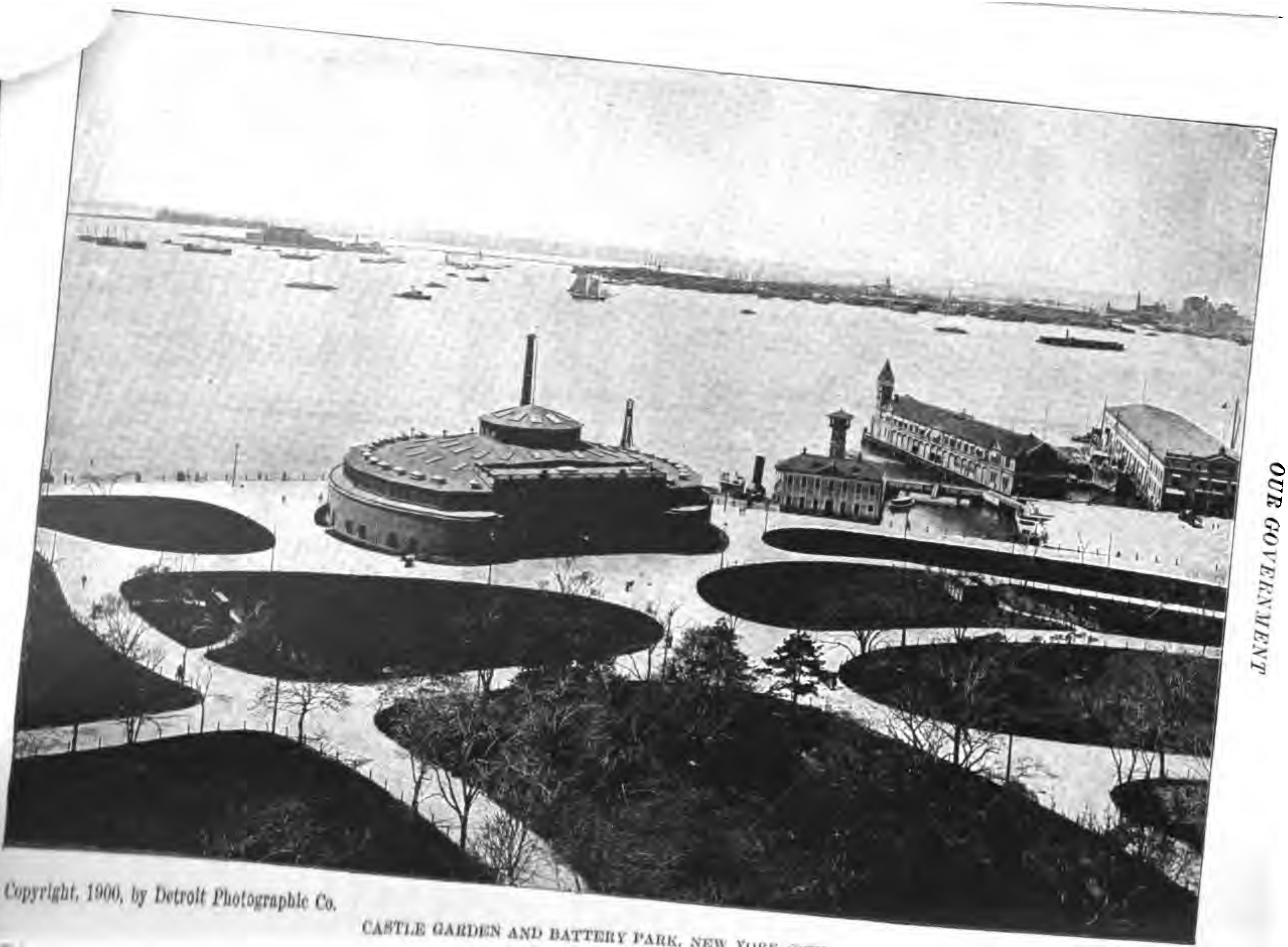
We notice that the Labor Department has general oversight of immigration. Everyone knows that the general question of immigration is of great importance to the United States, it will probably be of still greater importance in the near future. On our western shores we have to guard against a mass of undesirable immigrants coming from Asia. They are undesirable simply because they are not absorbed into the general mass of our people. They do not measure up to our standards of living. Severe restrictive laws have been in force. We have all felt that our ports have been too freely open to immigration from Europe of late decades. We have lately enacted literacy tests. It is thought that safeguards should now be increased against a flood of immigrants from Europe, many of whom are not fitted for, nor in sympathy with, our system of government. For the one hundred and twenty-five years ending 1915, nearly 33,000,000 immigrants entered our country. This is an average of over 260,000 a year.

DUTIES OF THE BUREAU OF IMMIGRATION.

The Bureau of Immigration applies the laws concerning the admission and rejection of immigrants to the United States, and also the deportation of aliens. The commissioner-general is charged also with the protection of, and assistance to, immigrants reaching this country; and pays particular attention to the problem of distributing them as advantageously as possible throughout the United States. He co-operates with the other departments of the government concerning the education and employment of immigrants and other matters pertaining to their welfare. All the immigrant stations of the country are under his supervision, as is the prevention of the surreptitious entry and smuggling of immigrants.

BUREAU OF LABOR STATISTICS.

It was the important work of this bureau that occasioned the formation of the new department. It is concerned with questions of great interest to organized labor. The bureau collects, collates, and reports facts regarding the welfare of wage-earners. It publishes bulletins concerning its findings, which cover a wide range—for instance, wholesale prices; retail prices and the cost of living; wages and hours of labor; women in industry; workmen's insurance and workmen's compensation; conciliation and arbitration in labor disputes. Under act of



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CASTLE GARDEN AND BATTERY PARK, NEW YORK CITY.

This is the extreme southern end of Manhattan Island on which New York stands. The oval building is Castle Garden, which for many years was the receiving station for immigrants until superseded by Ellis Island, in the bay. The buildings to the right are steamship piers and across the mouth of the North River, or Hudson, Jersey City appears.

May 30th, 1908, the Bureau also administers compensation to certain classes of employees of the United States for injuries sustained in the service of the government. The commissioner of labor statistics is appointed by the president by and with the consent of the senate.

BUREAU OF NATURALIZATION.

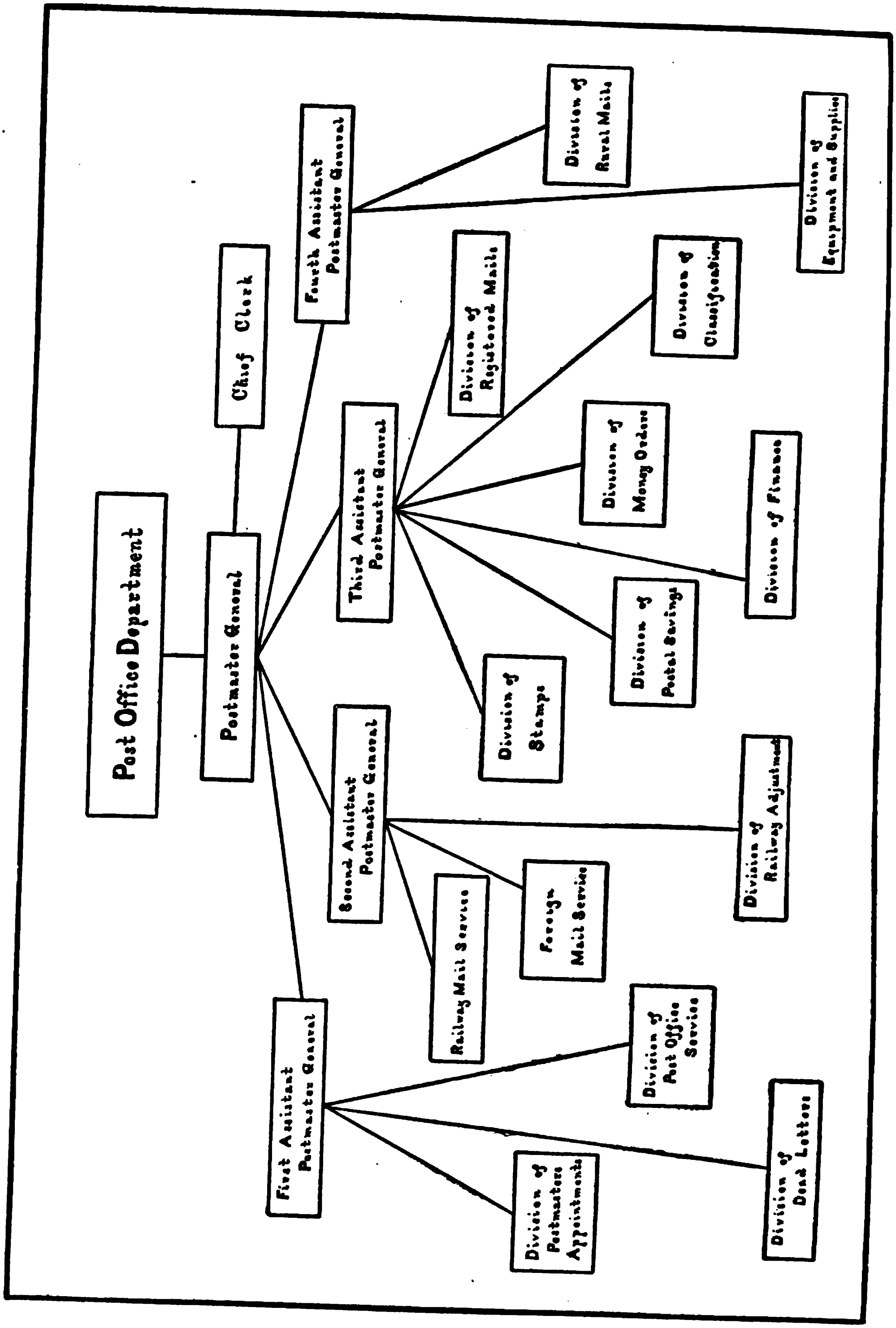
The Department of Labor has charge of the naturalization activities of the government. With the exception of certain Oriental people (as Chinese) immigrants to our country are entitled to naturalization if they desire, but certain restrictions surround the granting of this privilege. He must file a declaration of intention to become a citizen. Two years after that he may file a petition for naturalization. He must set forth certain essential facts, among others, that he is in no way opposed to organized government and he must absolutely and forever renounce all allegiance or fidelity to any foreign government of which he may be a citizen or subject. Germany passed a law which authorized her subjects to make such declarations but still retain their German citizenship, the design being to implant in this country a mass of citizens who would be expected to work, vote, and ultimately to fight for the interests of Germany.

CHILDREN'S BUREAU.

Perhaps it is not generally known that there is a bureau of United States government charged with the study of all questions directly affecting children's welfare. This bureau is not simply concerned with children's labor but it is charged to investigate and report upon all matters pertaining to the welfare of children and child-life among all classes of our people, and especially to investigate the questions of infant mortality, the birth rate, orphanage, juvenile courts, desertion, dangerous occupations, accidents and diseased children, employment and legislation affecting children in the several state and territories. The functions of the bureau are thus largely investigative. It has no power to administer anything or to regulate anything, and the act creating the bureau stipulates that "no official, or agent, or representative of said bureau shall, over the objection of the head of the family, enter any house used exclusively as a family residence." It is to serve as a centre to which people can turn for definite information regarding child welfare movements, so that every individual or organization working for children can learn of, and profit from, the experience of others.

POST OFFICE DEPARTMENT.

No executive branch of the government more intimately concerns the home life of the citizens than the Post Office Department; especially since it is now reaching out to assume control of all methods by which intelligence is transmitted whether by writing or printing, telegraph or telephone; and it seems about to become the greatest express carrying business in the world and also the greatest savings bank system. We are of course more or less affected by the activities of all departments —state, war, labor, etc.—but every day of our lives we experience the benefit of the post office department. Modern business and social life were impossible without it. One could tell from a study of the graphic of this department that it was indeed very important. Notice the divisions among


Post Office Department
Postmaster General
Chief Clerk
Fourth Assistant Postmaster General
Division of Rural Mails
Division of Equipment and Supplies
Third Assistant Postmaster General
Division of Registered Mails
Division of Classification
Division of Money Orders
Division of Finance
Division of Postal Savings
Division of Stamps
Second Assistant Postmaster General
Division of Railway Adjustments
Foreign Mail Service
Railway Mail Service
First Assistant Postmaster General
Division of Post Office Service
Division of Dead Letters
Division of Postmasters Appointments

which the vast business of this department is divided and observe how they concern our daily life. During the World War the post office department was able to do most effective service in assisting other executive departments in carrying out measures necessary for war purposes,—in censoring mail, in providing post office facilities at cantonments, in French camps, in floating Liberty loans, selling war saving stamps, in enforcing lessons in thrift, etc.

POSTMASTER GENERAL.

The postmaster general is the director of the entire postal service of the country. His power over his department is particularly untrammelled and broad He appoints all the important officers in his departments, except the assistant postmasters general and the purchasing agent, who are appointed by the president. He makes the contracts with railroad lines, steamship companies and other agents of transportation for the conveyance for the mails; and concludes postal contracts with other countries, although these latter must receive the approval of the president. He adds new postoffices to the list and abandons old ones, according to his judgment; and his discretion is the sole factor in enlarging or contracting the postal system in its various details. It is interesting to know that Benjamin Franklin was the first postmaster general for the colonies, appointed by the continental congress, 1775. It will be noticed that the postmaster general is directly assisted in his work by his chief clerk.

ASSISTANT POSTMASTER GENERAL.

There are four assistants, designated as first, second, third and fourth assistant postmasters general. First assistant postmaster general has charge of appointments, salaries, and allowances, dead letters and of the post office service, including delivery of mail within cities. Second assistant postmaster general has charge of the railway mail service of foreign mails and of general mail transportation matters. Third assistant postmaster general has charge of stamps, money orders, registered mail, postal savings, and other financial responsibilities of the department. Fourth assistant postmaster general has charge of the rural mail service and supplies.

FIRST ASSISTANT POSTMASTER GENERAL.

The first assistant postmaster general has three divisions under his supervision. The division of postmasters appointments, as its name implies, has charge of appointments. Since 1917 all postmasterships in the department are under civil service, this is true even of the first class offices, the postmasters are selected from leaders in competitive examinations. The division of postal service considers questions that will make the department more responsive to the needs of the day. Our postal system is the result of a growth, a development, one departure suggesting another. Free deliveries in cities only began in Lincoln's administration; rural free delivery in 1897; postal savings banks in 1911; the parcel post came in 1913; motor truck postal service 1917; aerial mail in 1918. Improvements will doubtless continue, keeping pace with increase in population and inventive ingenuity.

DIVISION OF DEAD LETTERS.

Dead letters is a name to cover all pieces of mail matter which cannot be directly delivered because of faulty direction. Often very odd methods are used to direct mail, pictures sometimes being used instead of writing. The post office department usually solves such riddles and delivers the mail to its proper destination. Letters and packages unclaimed, unaddressed, or misdirected, are sent to the dead letter office. The division saves millions of dollars for those interested by eventually returning money and valuables to the sender, in cases where the person for whom they were intended can not be found. Often snakes, dynamite and other freakish things are found in unclaimed packages. If the sender can not be found the money is turned into the treasury.

SECOND ASSISTANT POSTMASTER GENERAL.

The duties of the second assistant postmaster general are concerned with the railway mail service and the foreign mail service. The railway mail service is an extremely important branch of the department. The first definite railway mail route was established in 1864. That service has grown with the development of our country. It now employs many thousand men, operates on nearly all railway lines of our country, and the aggregate mileage covered runs

Opening dead letter packages in the Dead Letter Office of the Post Office Department. All kinds of curious merchandise and periodicals, and even infernal machines, are received here and opened. When a large amount of merchandise is collected, it is placed in blind packages and sold at auction.

far into the hundreds of millions of miles yearly; while the number of pieces of mail handled is numbered into the billions. So efficient is this service that mails are carried, sorted, pouched, and delivered to every point desired, without delay at the distributing point. The work is so exacting that clerks must be well versed in its requirements. Every office in a territory must be known to every clerk, and no forgetfulness or error in placing in the mail bag is permitted. Extremely stringent examinations are held for applicants for positions in the railway mail service, and so well has the clerk learned his lesson, that on an average, only one error is made in the sorting and delivery of 10,428 pieces of mail.

Model representing Porto Rican Mail Carrier in the Post Office Department.
Model for exhibition at the Louisiana Exposition at St. Louis.

Time is such a factor in the railway mail service that new trains are being constantly scheduled by the railway companies, and all sorts of devices are used to secure the rapid transit of mails. Now, the fast mail train crosses the continent four hours ahead of any passenger trains, and often between Chicago and Omaha, a speed of from 80 to 90 miles an hour is attained. In this rapid race many smaller stations must necessarily be swiftly passed. The mail received by the railway mail cars at such points is taken on by an automatic device like a crooked arm, projecting from the open door of the cars, which, by pressure of a lever, will reach out, seize a bag of mail fastened to a post on the railway platform, and hurl it inside the car. Mail for these stations is dropped off generally by hand. The railway branch of the postal service is dangerous and many postal clerks have been killed or injured. In this branch of the service in order to save time in the final delivery of mail at its destination in large cities, men well informed as to these cities are on board the fast trains, who sort the mail into the pouches so well, that the latter may be taken directly from the train to the numerous sub-stations in the cities. The compensation of railways for their service is under the supervision of the railway adjustment division of the service.

FOREIGN MAIL SERVICE.

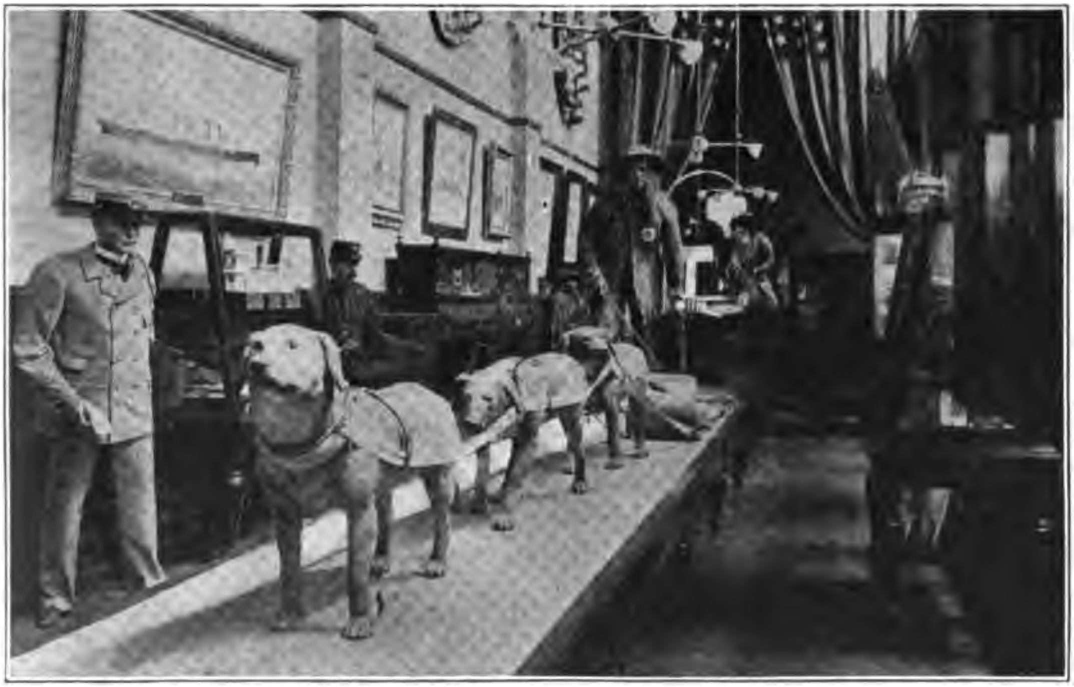
Many million pounds of mail for foreign countries are handled every year. During the world war this amount was enormously increased by mail to and from our forces in France. There are reciprocal domestic rates on letters between the United States and most of the countries in the western hemisphere, in addition, the United States has parcel post conventions with fifty-three countries and colonies.

Our country is a member of the International Postal Union. That is to say the principal nations of the world have entered into arrangements for the mutual exchange of their postal business. Switzerland, at the head of the union, acts as a sort of postmaster for the entire world, as the business of the union is transacted at Berne, Switzerland. This has proved a great convenience for the business world. Sea "liners" have post offices aboard similar to those on fast trains. Thus mail may be sorted en route, and given direct to local carriers in foreign countries, without having to go through land offices. Many tons of mail are carried between trains and the mail steamers in the harbor of New York, by the transfer boat, "Postmaster General."

Cancelling postage stamps in the post office. This machine is a late invention, and is operated by electricity. It cancels from three to five thousand letters a minute.

AERIAL MAIL.

A new epoch in post office development came in 1918 by aerial service, which has already been described in the "Wonders of the Flying Age." We do not realize the possibilities of this new service. The service between Washington and New York was inaugurated May 15, 1918. There is one round trip daily. The time is about two and a half hours, a reduction in time of between two and three hours between the two cities. Already about ten tons of first class mail is handled monthly, but this is only a beginning.



Alaskan Mail Carrier and dogs at the Post Office Department, for exhibition at the St. Louis Exposition.

The time between New York and Chicago will be reduced to nine hours as against twenty-one hours by the limited at present, leaving either city in the morning, mail can be delivered by carriers in the other city the afternoon of the same day. We do not realize what this saving in time for the country at large; from Boston to San Francisco; from Chicago to New Orleans; from the United States to commercial centers in South America, to Europe, and the world at large, means. Remember this, civilization has advanced with every improvement in transmission of intelligence from section to section. With wireless telegraphy and telephony, with aerial transmission of mail, we greet the wonderful development of the new age which we all know is upon us.

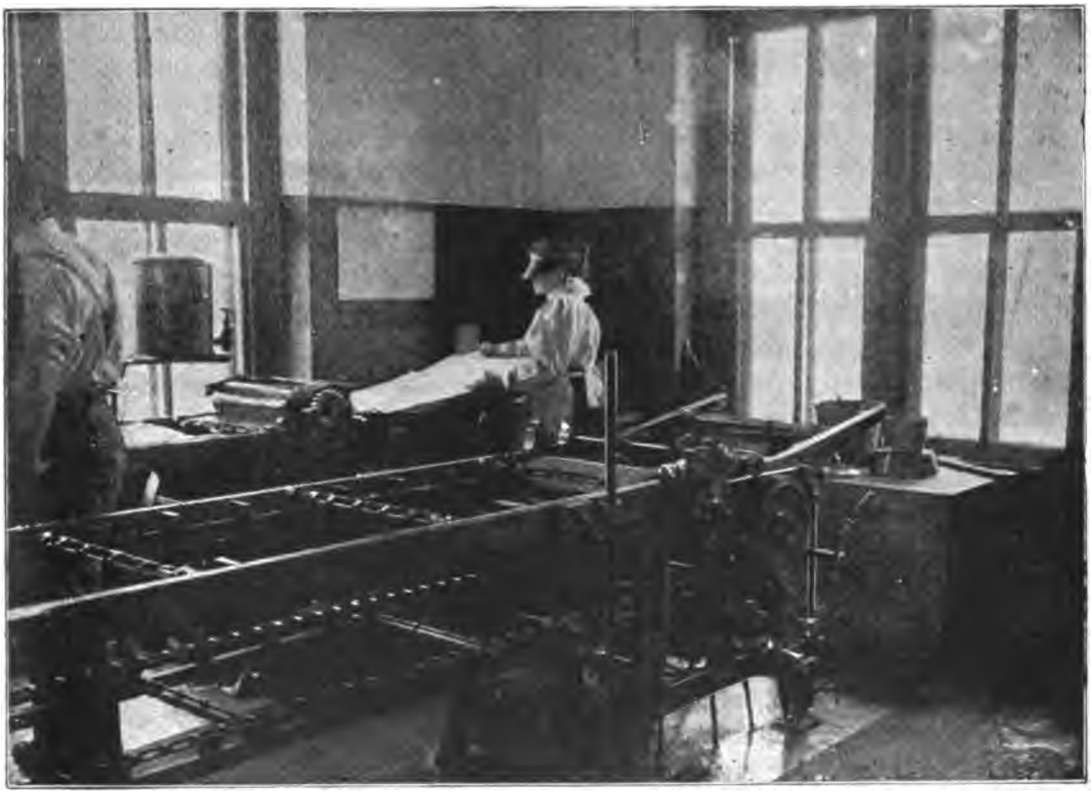
THIRD ASSISTANT POSTMASTER GENERAL.

Examining the graphic, we note that the third assistant postmaster general exercises general supervision over the financial end of the postal business of our country. All divi-

FIRST AERIAL MAIL FROM WASHINGTON TO NEW YORK.

An epoch making trip, the first aerial mail from Washington to New York. Lieut. George Boyle, the pilot on the left. Maj. R. H. Fleet, in charge of the aerial mail on the right. The first step in a wonderful future of mail carrying activity.

sions in his department are of vast importance and every one has developed with great rapidity, far faster in proportion than the growth in population of our country. Their work serves as business barometers, indicating in no uncertain terms business conditions and financial prosperity or the reverse of our country.



Gumming postage stamps in the Bureau of Engraving and Printing. About two hundred thousand stamps are gummed each day.

DIVISION OF STAMPS.

The Bureau of Engraving and Printing in Washington not only prints all our money, bonds, etc., but the myriads of stamps required in our correspondence, internal revenue stamps, and stamps for special seasons as War Saving Stamps. The sale of postage stamps is now approaching four hundred million dollars in value yearly. The number required runs far into the billions, in addition there are nearly a billion postal cards required, nearly two billions of stamped envelopes, not to mention the billions of postal saving stamps, or, during the great war, the hundreds of millions of war saving stamps and thrift stamps needed. Evidently the work of this bureau is of vast importance and printing stamps for the post office department is among its most important activities. Stamps are printed on specially manufactured paper and the same care is used in handling it as of paper on which money is printed. Every sheet of stamp paper is carefully accounted for. Four hundred stamps are printed on a sheet that goes through hundreds of hands.

The method of applying the gum to stamp sheets is entirely mechanical except in the counting. The sheets are fed into a hopper, where they pass between rollers, the lower set of which revolves in a vat of melted gum. This vat is directly over a heater which is regulated automatically with scientific accuracy. Over these gum rollers the stamps pass in a continuous chain, which carries them through wooden compartments heated by hot water pipes. When the sheets emerge the gum is dry, and they are ready for the counter. The basic principle of the gum, which the government manufactures, is cassava starch.

For all practical purposes the history of postage stamps begins in the United Kingdom, and with the great reform of its postal system in 1839-40. The use of adhesive stamps in the United States was authorized by an act of congress approved March 3, 1847, and on June 1, 1856, prepayment by stamps was made compulsory. Until 1863 the rates of postage were based upon the distances over which the mails were conveyed. In 1846 these rates were: not exceeding 300 miles, three cents; exceeding 300 miles ten cents. In 1851 the rates were reduced to three cents for distances not exceeding 3,000 miles, and ten cents for distance exceeding 3,000 miles. In 1863 a uniform rate of postage without regard to distance was fixed at three cents, and on October 1, 1883, the rate was reduced to two cents. As a revenue producing measure the rate was temporarily increased during the world war to three cents. By this means $44,000,000 was turned into the treasury in 1918. A special stamp for air service was printed in 1918.

DIVISION OF POSTAL SAVINGS.

To encourage the people of small means to deposit their savings where they would be immediately available in emergency, and at the same time be secure from misappropriation while earning a small interest, postal savings banks have been instituted by progressive nations. The United States established such banks in 1911. Accounts may be opened by the deposit of a dollar or a larger sum in multiples of a dollar. To encourage children to begin such accounts special savings stamps are sold for ten cents each. Ten of these may be deposited for a dollar. Additional amounts may be deposited when convenient. The total amount that one may have on deposit is now $2,500. This innovation has proved a great success. It has encouraged thrift among the young, many children having become depositors; and it checked the outflow of money to Europe by foreigners, suspicious of privately conducted savings banks. The number of depositors has steadily increased, the average deposit steadily risen, and the total amount on deposit greatly increased. This amount of money is not withdrawn from general circulation. Large amounts of it are reinvested in interest bearing bonds of the United States. A postal savings depositor, when he has $20.00 or any mulptiple of that sum on deposit, may buy postal bonds payable in gold, free from all forms of taxation and bearing interest at the rate of two and a half per cent.

DIVISION OF MONEY ORDER.

Money orders were first utilized in 1864 to facilitate the transmission of money from soldiers in the front to their homes. This division also has grown with increasing business in the United States until now its transactions total nearly one billion dollars in value of orders issued yearly. There have been established an international money order system by means of which money can be sent to, or received from, most European countries. Transactions in this department with the United States run far into the millions yearly. In this division, as in others, mechanical assistance in the way of adding machines simplifies the work. In the postoffices of our large cities—like New York, Philadelphia or Chicago—the money order transactions for each day are the equal of the business transacted in a large bank and require the service of a large force of clerks.

DIVISION OF EQUIPMENT AND SUPPLIES

It is evident that equipment such as mail pouches of many kinds must be supplied in quantities. Pouches of all kinds are manufactured and repaired, and other equipment made at the mail equipment shop in Washington. The trend of bags is from the East westward, and from great business centers towards the country districts. Every year many hundred thousand bags are repaired and put into service, most of them through the New York postoffice. Naturally, some postoffices will accumulate more bags than they can use for return mails. Cincinnati, St. Louis and other cities are made distributing points from which a call for bags may be supplied at almost any time.

The greatest flow of bags, after they get into service, is from the offices at Washington, Baltimore, New York, Chicago, Boston and Philadelphia. The period of greatest activity is during the Christmas and New Year holidays, when business firms and individuals are sending out great quantities of packages by mail. The bags containing these gradually return to the central stations late in January, and once more they flow out in May, when the spring advertising season sets in. Of the numerous kinds of bags there must be those for the mountain carriers, the runner on snowshoes, knapsacks, and the bags for the Alaskan dog teams, and saddle bags for the pony express. One of the recent odd bags devised is a perforated affair, for transporting live queen bees to the Islands of the Pacific.

CITY DELIVERY SERVICE.

Several departments of the service deserve particular mention. The free city delivery system, established in 1872, is one of these. This system makes possible the delivery of mail to the door of every resident of the larger cities, without the least inconvenience. The marine postal service on the great lakes involves the delivery of mail sent to and from sailors on moving vessels. The smoothness of the operation of this branch of the service can be noticed best at the mouth of the Detroit river, where during eight months of the year vessels pass every three and a half minutes of the day and night. This great fleet has a perfect mail service. All vessels are met and mail is collected and delivered, with the vessels in full motion. Water-tight bags are used for this purpose, as a safeguard in case the collector should have a "spill." The letters are stamped on the back with the name of the vessel to which they are destined.

RURAL FREE DELIVERY SYSTEM.

There is nothing perhaps so remarkable in the history of the postoffice department as the rural delivery service. By means of this delivery, farmers throughout the country receive their mail regularly, at stated intervals, without the necessity of calling for it at the postoffice, possibly many miles away. The rural delivery routes are so popular that, in many cases, to secure them, the farmers have paid for the grading necessitated by the establishment of routes. Among the advantages derived from this service are larger postal receipts and a greater use of newspapers and magazines, which keeps the people better informed, and increases the value of land because of the better means of communication. Farmers also are able to keep in closer touch with market quotations, through the papers, thus enabling them to get best prices for their produce.

PARCEL POST SYSTEM.

The establishment of a Parcel Post system in 1913 marked the entry of the United States into the express business and this work devolved on the postal department. Foreign governments had already perfected similar systems and results were exceedingly gratifying. In carrying ordinary mail, the government charges a flat rate, that is to say, at the rate of so much an ounce, no matter whether the distance of transport be five miles, or five hundred, or five thousand. But, manifestly, such a course cannot be followed in any kind of express business. The rates charged must vary with the distance. By a series of cross lines mathematically exact, the map of the United States is divided into sections each 30 square miles in area. These are numbered, and each section, called a unit area, is made the center of a series of zones, and the rate charged at the receiving office depends upon the zone in which the office to which the package is to be sent is situated, relative to the sending office. The parcel post has proved extremely popular and the development has been very rapid. A C. O. D. and an insurance system has been installed and a letter can now be attached to the package, the letter going at the usual letter rate. This permits simultaneous delivery of communication and parcel, which is often a great convenience.

MOTOR TRUCK PARCEL POST ROUTES.

Beginning in 1916 the postoffice department has been experimenting with a parcel post rural delivery and express system over motor truck routes that seems the first step in a great advance. The design is to establish truck lines through productive sections. contiguous to large towns, linking them up into large system covering the entire country. The trucks running on the roads not only carry mails but gather up supplies of all kinds of country produce and deliver them in the neighboring cities, carrying from the city such supplies as are needed in the rural sections they serve. These routes have proved very helpful to rural life and very profitable as well. One helpful result is the stimulus to good roads building. Farmers are kept acquainted with market rates for their produce, since postmasters furnish a list of prices.

QUESTIONS ON OUR COUNTRY AND ITS GOVERNMENTS.

What is the Constitution of the United States?

What body of men framed it? By what authority were they convened?

Did all the states send delegates to the convention?

What was the announced purpose of the convention?

Mention some eminent statesmen who were members of the convention.

Where did it meet?

How long was it in session?

What were some of the difficulties that had to be overcome?

How did Washington feel about the situation?

What is meant by Federalism? By Antifederalism?

Did all the states ratify the constitution?

Why were some dissatisfied?

Did the constitution settle all points at issue between the states?

In your own language state what you understand was the effect of adopting the constitution? What would have been the result if the states had not accepted and abided by the constitution?

What authority settles the legal meaning of the language of the constitution?

Can a state do as it pleases about obeying a law of Congress?

How many states are there?

Will there be any more states? If so, where will they be formed?

Suppose Alaska wishes to become a state, would we have to admit it as a state?

Suppose New England wished to establish a separate republic, could they do it?

Montana is a very large state. Could Congress divide it into two states if the people of Montana objected?

Suppose Texas wished to divide into separate states, could Congress keep it from doing so?

As a matter of fact, Virginia was split apart into two states. In your own way decide how this came about. (Study the time when it was done.)

Rhode Island is a very small state; Texas, very large one; how does the constitution provide for equality among states thus differing?

Did the constitution establish a union or a compact of or between the states?

Of how many articles does the constitution consist?

How can it be amended?

How many amendments have been made?

What is the last amendment?

Ten amendments were adopted within a few years—what occasioned so many?

What are the co-ordinated branches of government?

What amendment settled questions raised by the Civil War?

In general what is the legislative branch?

They say our Congress is bi-cameral, what do they mean?

How many senators are there?

Who is the presiding officer?

Suggest some reason why the Senate must ratify treaties? Must the House of Representatives also concur in a proposed treaty?

For a long time Senators were elected by the legislatures of the several states, suggest a reason for that method.

How are they elected now?

What constitutional amendment effected that change?

For how long a term are senators elected?

How old must a senator be?

Suppose the president appointed some one—say John Smith—ambassador to England, would that act of the president, alone, make him our ambassador?

But suppose the House of Representatives did not wish John Smith to be ambassador, could it prevent him from becoming such?

For how long a term are Congressmen elected?

How do they determine the number to be elected from each state?

But how do they determine the number of people entitled to one Congressman?

How old must a Congressman be?

How is the speaker of the House of Representatives chosen?

Do the two houses of Congress differ in their powers?

Can either house initiate a bill? If the houses do not agree on the proposed bill can either house force it through?

Must Congress meet at some certain time?

Suppose Congress has adjourned, but it becomes necessary for it to meet, how can this be accomplished?

If Congress is in session and one house wishes to adjourn, the other does not, can Congress adjourn? Can any authority adjourn Congress except Congress itself? Is Congress automatically adjourned at a specified time?

Suppose you—a private citizen—thought it would be wise for Congress to pass a certain measure—how would you go about it?

Suppose the president does not consider a certain bill passed by both houses of Congress a wise one, can he prevent it becoming a law? But can Congress over-rule a president in this mattter? But suppose Congress passed such a bill only a week before it adjourned, can it then overrule the president? Does the president have to sign all bills?

Suppose the House of Representatives passed a bill, but the Senate changed it in some respects, can the president choose which bill to sign?

But let us suppose Congress has passed and the president has signed the bill, is there any power that can defeat such a bill?

Suppose a state has passed a law thought to concern only its own affairs, can Congress over-rule that law? Is there any power that can over-rule it?

How many Justices compose the Supreme Court?

Are they elected or appointed?

How did the old question of Federalism arise in the Supreme Court?

For how long a period does a Justice of the Supreme Court serve?

Suppose he is not fitted for his office, is there any way of removing him?

Which branch of Congress has jurisdiction in such a case?

Who is the chief executive of the United States?

State in your own language his duties.

A president to be eligible has to be of a certain age, what is it?

Suppose a boy born in England, but who lived in the United States, even naturalized here, is he eligible to the office of president?

For how long a time is a president elected?

Why is it that no president has been elected to a third term?

But suppose the majority of our citizens wished him for a third term, is he eligible?

How is a president elected?

Suggest some reason for selecting such a cumbersome method of choosing a president?

Is there any way of removing a president from office before his term has expired?

Can a president by his own power declare war?

Can he make terms of peace? Do both branches of Congress have to concur?

Has he any power to commit the United States to a definite line of policy that he thinks wise?

Can he make any alliances with foreign nations by his own authority? Does either branch of Congress have to concur?

What house of Congress must concur in all his important appointments?

In times of war which has the greater

authority, the president or the commanding general of the army?

War having been duly declared, can Congress interfere with the president's general management of the army and navy?

How many executive departments are organized to assist the president in his work?

Can this number be changed or is it fixed in the constitution?

What is the president's cabinet? Suppose all the cabinet disapproved the president's action in any particular case, is he compelled to accede to their judgment? Has the president power to supervise the work of the secretaries in their several departments if he thinks best?

Should the president die during his term of office, who succeeds him?

What are the duties of the Secretary of State?

Is he in any way superior to other cabinet officers?

Is there any contingency in which he might become acting president?

Suppose the secretary of state wishes to prepare an important paper to be sent to a foreign government, would this paper be considered by the cabinet? There is an officer in the department who might advise the secretary, who? If the president decides to prepare such a paper himself, can he do so?

What bureau would prepare ordinary foreign correspondence?

Suppose some question arises concerning Chinese immigration, who would handle it? Suppose it be some question concerning Mexico, what bureau has charge?

Suppose you wished to be appointed to a consulship, what bureau would have charge of it?

How many assistant secretaries of state are appointed?

If we wish to extradite a criminal from Europe, what bureau attends to the details?

Sometimes persons wishing to visit Europe, procure a certain paper from the state department, what is it?

The president issues a Thanksgiving proclamation, the secretary of state attaches something to it, what is it?

If our government has official business with China on the one hand and Persia on the other, would the same bureau in the state department handle them? If different bureaus, which one would handle the Persian business?

A person born in Italy wishes to become a citizen, what must he do? What bureau has supervision over legal questions concerning such operation?

What official in the state department has general supervision?

What executive department of government attended to the details of the various Liberty Loans?

A farmer wishes to obtain money from the government on his farm, what bureau has charge of such business?

Is the secretary of the treasury the treasurer of the United States?

If you have a paper dollar, what bureau printed it?

Suppose it be a silver dollar, what bureau had charge of it?

You have often noticed statements of national banks published in your paper, what officer called for them?

Suppose you have a large amount of money due you from the United States, no one denies the claim, but there is one official in the treasury who must O. K. it, who is he?

Is it Secretary A. B or C who has general charge of such matters?

In your home town the United States may

own the postoffice building, what department in the treasury drew the plans?

What secretary has general oversight of that bureau?

The president on his travels is atttended by special guards. What bureau in the treasury has charge of those guards?

How is it that the treasury department has charge of such business?

Look at that paper dollar again. On the lower line it is signed by two treasury officials, what does the one on the left hand do? The one on the right?

When you return from a foreign trip, your baggage is examined. What bureau has charge of it?

There was an officer of the treasury department stationed at every distillery, who was he? Why so stationed?

In some sections such officers are greatly disliked by the people, why?

Which department, think you, is the more important,—state or treasury?

Which one more intimately concerns your daily life?

If you wish to secure a patent, what office of what department will attend to it?

What are the duties of the Interior Department?

Looking through this volume you note a number of full page illustrations secured from this department, what do they illustrate? What bureau has general oversight of that business?

Does the bureau of education of the Interior Department have anything to do with your home school? How is it with schools in Alaska?

Where is the Interior Department building a railroad?

What is the Reclamation Service?

If there should chance to be a terrible accident in your near-by coal mine, what bureau in the Interior Department would send a rescue force?

A few pages back we read about "Bird Reservations," what bureau has charge of them? Is it the same bureau that has charge of Indian reservations?

We have in this volume an illustration of "Mountains of oil," what interior bureau has charge of such matters?

What is a national monument?

On the pension books of the Initerior Department, what is the official name of the World War?

What is the general purpose of the Department of Agriculture?

We considered our great packing house industries, what bureau of the Agricultural Department inspects packing houses?

Why do they need inspectors?

What is the general business of the bureau of animal industry?

Does it have any connection with the boys and girls club movement?

Outline the work of the bureau of plant industry.

We have told you about a very celebrated research worker in this field, who is he?

We have considered the curative powers of nature in the plant world, explain about it.

What is the work of the bureau of entomology?

Mention one means it employs to assist plants.

One bureau of the Agricultural Department employs hunters and trappers, what one? Why does it need such service?

They are trying to raise skunks, what for?

What invention has stimulated good road building? What bureau of the Agricultural Department has oversight of road building?

If your state wishes to receive help from the Agricultural Department in construction of good roads, what step must it take?

Does the State Relations Service have any connection with your school?

Consider the work of the Agricultural Department as a whole, in value, how do you think it compares with the work of the Interior Department?

How does the Department of Justice differ from the Supreme Court?

Can this department declare an act of Congress unconstitutional?

Who is the official at the head of the Department of Justice?

What are the two general branches of the business of this department?

How many assistant attorneys general are there?

One seems to be of special importance, what are his duties?

What is Inter-state Commerce?

Does the constitution attempt to regulate such commerce?

Does the Department of Justice have anything to do with legal questions in other departments?

Suppose the president wished advice on some constitutional question, whom does he ask for such advise?

What executive department of government attends to the details of the president's duties as commander-in-chief of the army?

Can you suggest any reason why the head of that department is generally a civilian?

Studying the graphic, what military officer assists the secretary of war in the military activity of his department?

Is the chief of staff the commanding general of the army?

What is the purpose of the general staff? Are there any civilians on the staff? How many army officers?

What is the Army War College?

Mention some of the duties of the general staff in times of war?

How many administrative bureaus in the War Department?

What invention greatly increased the duties of the signal bureau?

Soldiers must receive food and clothing, what bureau is charged with the duty of providing the same?

They must have materials wherewith to fight, what bureau is charged with procuring such supplies?

What is coast artillery for?

What is the work of the Bureau of Insular Affairs?

For coast defense purposes, in what district is San Francisco?

What organization in the War Department had charge of the cantonments?

What executive department assists the president in discharging his duties as commander of the navy?

What board advises the Secretary of the Navy in naval matters?

What class of men were selected for the Naval Consulting Board?

What is the naval observatory?

What has astronomy to do with the navy?

Do any clocks in your town depend on that observatory for time?

How do they receive it?

What are flying machines for naval purposes called?

What bureau of the Navy Department has charge of the wireless stations?

What is the marine corps?

What immensely important victory did that corps win in the World War?

Briefly describe the work of the other naval bureaus shown in the graphic.

What activities are under the general direction of the Department of Commerce?

What bureau in this department could weigh a hair?

What bureau of this department assists our manufacturers? How is this assistance rendered?

But in order to render this service they utilize the work of a bureau in another executive department, what one?

We have considered the Interstate Commerce Commission, what bureau in the Commerce Department exercises very similar powers?

Can either of these commissions interfere with the commerce of a corporation doing business confined to one state?

Describe the work of the bureau of fisheries.

A very valuable resource of Alaska is under their care, describe it.

A bureau of this department determines how many congressmen your state is entitled to, what one is it?

What other information is gathered from the work of this bureau?

There is a bureau of navigation in both the navy and commerce departments, what is the difference in their work?

There is a survey bureau in the Interior Department and the Department of Commerce, what is the difference in their work?

What is the duty of the Secretary of Labor?

In the past what was the average number of immigrants to our shores?

Why is it necessary to regulate immigration?

How does the immigration bureau supervise immigration?

The bureau of commerce takes the census, but the bureau of labor gathers a mass of statistics also, what are they? Enumerate some of them.

What is the object sought?

There is a bureau in the State Department concerned with naturalization, how does it differ from the work of the Department of Labor in naturalization?

Mention steps necessary to take if an alien wishes to be naturalized.

Describe the work of the children's bureau.

Consider the nature of the activities of the Department of Commerce and that of Labor, which department, think you, is the more important? Give your reasons.

What can you say of the importance of the Postoffice Department?

The Postmaster General exercises peculiar powers, what are they?

If you wished to be postmaster in your town, what would you have to do?

Which assistant postmaster general would have charge of your appointment?

Mention some steps in the development of our present postal system.

When was aerial service instituted?

Nearly every one, at times, receives mail from the Dead Letter office, explain the work of that office.

When was the first railway mail route established?

Railway mail arrives at large cities all ready for the carriers, how is this possible?

How do fast trains take on mail?

What is the international postal union? Where are its headquarters?

What is the saving of time by aerial service between Washington and New York? New York and Chicago?

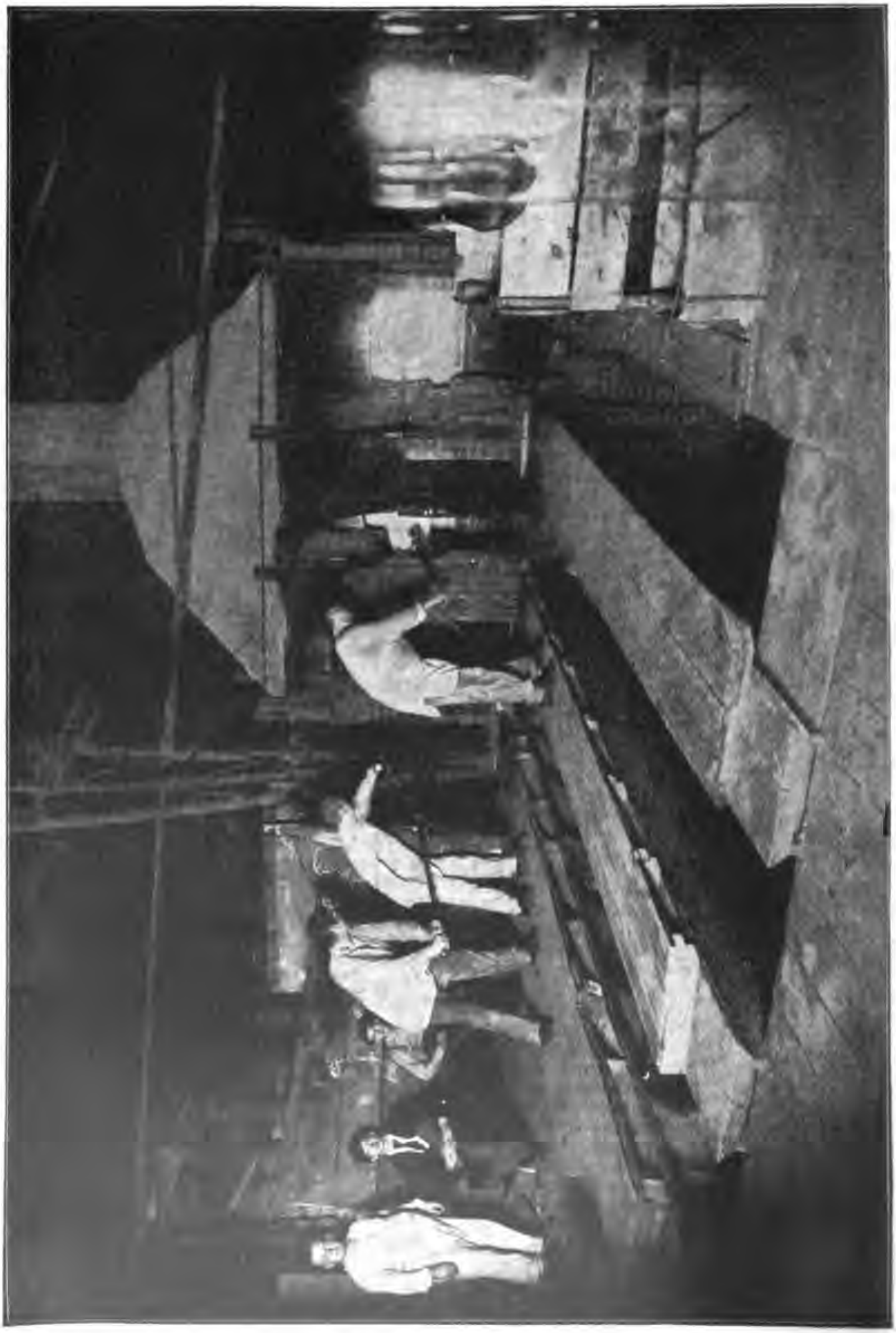
Can you send money to Europe by postal money order?

Can you send queen bees by mail?

BOOK VIII

THE HOW DEPARTMENT

Information for Alert, Inquisitive Minds, Explaining Manufacturing Processes. Knowledge that Creates Imagination and Suggests Ways of Advance. Information that Conduces to Efficiency in Life. Invaluable to All



WINDOW GLASS MAKERS AT THE MELTING FURNACES.

THE HOW DEPARTMENT

HOW GLASS IS MADE

Glassmaking is one of the oldest industries known, as it was made in Egypt long before the dawn of history. In modern life it has become a necessity. It admits light into our houses, while excluding the cold; in the field of science it furnishes the means wherewith we learn of the infinitesimal world, and also of worlds almost infinitely distant. A long list of everyday uses to which glass is applied occurs to us all. How could modern civilization be possible if glass were unknown? And yet less than four centuries have elapsed since glass was first used for windows in England or the first bottles manufactured.

Glass manufacturing is now one of the great industries in the United States. From the last census we learn that there were 363 establishments engaged in its manufacture, giving employment to over 75,000 men, turning out products valued at $92,095,203 yearly, and this industry was growing with great rapidity. Of the states reporting this industry, Pennsylvania was far in the lead, with Ohio second and Indiana third. Such intense heat is necessary in the manufacture that the question of fuel is very important, and the states where fuel is abundant and cheap are the ones where the industry flourishes. The most valuable single article of glass manufacturing are the lenses for our great telescopes, which are worth many thousand dollars. Of common objects, we would naturally think of window glass as being the most valuable product. But bottles and jars are far in the lead in value of products, blown and pressed ware second, and window glass third.

HISTORY OF GLASS MAKING.

The making of glass is surrounded with mystery, but few industries have greater antiquity. The earliest records found are those of sailors, shipwrecked near the mouth of the river Belus, who made a fire using the plant cale, which contains a good deal of potash, which acted on the sand and formed glass. There can, however, be no value to this story. The Egyptians made glass as early as 5,000 B. C. They were experts in the use of metallic oxides and making colored glass.

Glass making was introduced into Rome during the reign of Tiberius, the first clear glass coming into use during the reign of Nero. So interested was he in its manufacture that he paid the equivalent of $250,000 for two glass cups, which is the record price for glassware. The industry drifted into Venice, who sent her products all over the civilized world of the time. As a token of the esteem in which glass workmen were held in Venice by city decree they were entitled to be called gentlemen, a high honor for the times. It was late in the 16th century before its manufacture was introduced into England.

NEW PROCESS OF MAKING STAINED-GLASS WINDOWS

In a short article of this description, it is possible to give only the bare outlines of the art of making stained-glass windows. To begin at the beginning, when the exact shape and subject of a window is decided upon, a water color sketch is prepared to scale, and then the working drawings and cartoon in full size are made. The drawings are done either in monochrome, charcoal, crayon, pencil, or bister, in wash or in color or pastel, according to the taste of the artist.

The lead glazing lines are usually shown on the drawing, and for the guidance of the glass cutter a tracing of these lines is made on linen. Possibly, the most important, and certainly one of the most delicate functions in the making of a window, now follows—that of choosing the glass itself, for on this depends to a great extent the final artistic results, as will be presently explained. The artist stands by the cutter and chooses each tint, each sheet, and even indicates the particular part of each sheet most suitable for his purpose. For the color is not always even throughout the glass. What to an inexperienced eye looks like a flaw, a splash of different color, or a mass of air bubbles, is produced intentionally in the manufacture of the glass, and eventually adds to the beauty of the window. When the various pieces are chosen, they are cut to shape on the linen tracing. A tracer now marks on the pieces of glass the main lines of the artist's drawing. It is here that one may point out why stress is laid on the importance of the artist choosing his own glass, and not leaving it to the cutter.

A prevalent idea is that a stained glass window is produced by painting white or ordinary glass with various colors, but it is not so. It is in reality a Mosaic of colored glass, shaped by a pigment of one color only, and with the exception of what is called staining, which will be presently explained, the color of the glass is in no way changed. The pigment used is chocolate-brown, in color, and is made of the same earths as the glass itself, with some iron or copper added to give opacity.

The next process is to stick onto a sheet of plate glass, with hot wax, all pieces, placed in their proper order and position and the whole is then covered with a fairly thick pigment, and, while still wet, stippled to let the light through. When the pigment has dried, the lights and half tones are picked out and brushed away, here and there a shadow is strengthened with more pigment, and the work is ready for diapering and staining. The diapers, or patterns, are either painted on in thick opaque lines, or the existing paint is etched out with points, to the required design (see illustration). Staining is painting the back of such portions of glass as may seem desirable with nitrate of silver, which, when sufficiently heated, changes to a brilliant yellow. It can be so manipulated as to give shades from pale lemon to deepest orange.

The pieces of glass are now all dismounted and carefully laid in flat iron trays, the bottom of which contains a layer of white dry powder; the glass is so arranged that no two pieces touch. The trays are then placed in a kiln heated by powerful Bunsen burners, gradually brought to heat and as gradually cooled. The pigment which, as was pointed out, is made of the same earths as the glass on which it is painted, has become, by firing, part and parcel of the glass itself; it is no longer paint, but actual glass.

It is now ready for the glazier who, by means of the design or cartoon, puts the different pieces in their proper places, and joins them together by means of grooved leads, and solder. Around the ouside edge of the design, in order to bind the whole firmly together, is fixed a stronger piece of lead than that used to join the pieces of glass.

Now follows a very dirty process—that of making the window proof against the weather. This is done by rubbing under the leads a cement made of whiting, oil, etc. The whole window on one side is smeared with this, but it is eventually all cleaned off, leaving a deposit under the leads which makes it water tight. Again the glazier takes it in hand and solders onto the lead cross-bars of galvanized iron at proper intervals. It is now ready for setting.

The stone mullions of a window to be fitted with stained glass are grooved on one side deeper than on the other. The glass is slipped into the deeper groove first and then pulled back into the shallow one in the mullion opposite. The iron bars, called tee bars, are set into the stone on each side of the window holding the glass in place. The space between the outer lead of the glass and the stone work is now carefully filled in with cement, to prevent the rain beating through, and then the window is complete.

MATERIAL USED IN MANUFACTURE.

The principal material used in the manufacture of glass is silica, or in common language, sand. That, of course, is abundant, and yet as it contains chemical impurities the quartz rock is crushed and ground to

STAINED GLASS WINDOW—REPRESENTING A HUNTING SCENE.

sand to make the best varieties of glass. There is mixed with the sand a number of other articles known as bases, such as soda ash, salt cake, nitrate of soda, limestone, also lime itself, arsenic, carbon, manganese and litharge. These, or some of them (and sand is the essential and abundant article) are mixed in varying proportions, according to the kind of glass desired. This mixed material is known as the batch and some broken glass is always added. It requires very high temperature to melt silica, consequently in all glass factories, the furnace is the most important part.

The furnace most in use at the present day is the tank furnace. The batch is put in at one end, the sloping floor allows the molten material to gather at one end, though it covers the entire bottom to the depth of several feet. We can scarcely conceive of the intense heat which this statement implies. The working of molten glass depends on the fact that it passes from a liquid to a solid state without crystallizing, and when it is hot and in a plastic state it possesses ductility and malleability to an extreme degree. In former years glass blowing was a trade and is so still, but machinery is invading that field. Machines are now constructed that draw a continuous sheet of glass of any reasonable width, of desired thickness and polish. There are other machines that blow the great cylinders which make window glass quite as well as the most expert glass blower.

In the manufacture of plate glass, the molten glass is poured on a casting table with raised sides and the glass rolled any required degree of thinness. Wire glass is rolled plate glass in which wire has been imbedded during the rolling process. In pressed glassware the molten glass in a plastic state is placed in a mold, a metallic plunger pushed into the mold forces the glass to fill the space between the plunger and the mold.

HOW SILK IS MADE

This is a division of the textile industry, but there are a number of interesting details in connection with it. It is an industry in which virtually all of the raw material or raw silk is imported, thus differing from the majority of our manufacturing industries. The primitive home of this industry was China, and it flourished there for centuries before other nations learned the secret. About the year 550 A. D. the Byzantine emperor at Constantinople obtained a few silk worms from China, but the came concealed in a hollow cane. From these few worms there was developed the silk industry around the Mediterranean. Attempts have been made to raise the silk worms in the United States, and they can be raised, especially in California, but no great degree of success has attended these efforts. The fact is, raw silk can only be successfully produced in countries where there is an abundance of cheap labor, as in China, Japan and Bengal.

Silk in its finished state is an ideal product. It is at once durable, magnificent to the eye, tender to the touch, and its rustle is soft music to the ear. Hence it is easy to understand why the silkworm, from the earliest times, has been an object of much consideration and concern from a commercial and industrial point of view.

SILK COCOONS, AND THE SILK INDUSTRY

The Illustrations in this article are furnished by the courtesy of Belding Bros. & Co.

The art of reeling, or producing raw silk, has been carried on in China for ages, and so well did the orientals guard the secret of silk culture that the nature of the fibre was unknown in Europe for more than a thousand years after silk fabrics had been introduced there. China still takes the lead in the production of raw silk; but large quantities also are obtained from Japan, India, France and Italy. Every silk article ever made or exhibited was originally in the cocoon condition, and the fibre had to be put through a great variety of processes before it was finally ready to be woven into fabrics. The idea is quite common that the silk threads or fibres as they come from the cocoon are ready for the weaving loom without further work or preparation, but the fibres, after coming from the cocoon, must be manufactured before they can become of any value.

THE SILK MOTH AND THE SILK WORM.

The little bright colored silk moth deposits from 400 to 600 eggs, and then disappears and soon dies. The eggs, on being exposed to a temperature of 65 or 70 degrees, hatch rapidly, each one producing a short brown worm, which, with a ravenous appetite, feeds upon the leaves of the mulberry tree, consuming double its weight daily. In five weeks, it attains its full growth, having increased 8,000 times in weight. It is then three inches long, and as thick as a large, lead pencil.

THE SILK COCOON.

FEEDING THE SILK WORM.

The worm now seeks a convenient place to begin the formation of its cocoon, which is to protect it in the changes incident to caterpillar life. Having selected a site, it ejects from two small tubes near the mouth, a liquid, gummy substance which adheres to whatever may be within reach; thus anchored, the next move of the body in the opposite direction draws out the silked fibre. The worm then turns over and over toward the center of the cocoon, and pays out the silked cable as it goes, until it has spun itself almost to death, and has built around itself a cocoon of silked thread about a quarter of a mile long.

Thus imprisoned, the insect remains, if undisturbed, for about 15 days, when the end of the cocoon is moistened, and it emerges in the form of a moth. This, however causes the fibre of the cocoon to be badly tangled and twisted, so that it is necessary to kill the insect before it comes from the cocoon. This is done about eight days after the cocoon has been finished, by exposing it to the direct rays of the sun at a temperature of 100 to 125 degrees.

SECURING THE EGGS.

This shows the care taken by the Japanese government. The moths are laying eggs on regulation paper that will be inspected by government officers.

REELING THE COCOON INTO RAW SILK.

The cocoons are now ready to be reeled into raw silk. This is a very important operation, as everything depends upon the reeling, and the quality of the silk will be good or bad, according to the manner in which it is done. In silk countries the making of the cocoons is carried on as a separate business, distinct from the raising of silk worms, the cocoons being sold outright to the reeling establishments, which are known as "filatures."

If the reeling has been indifferently performed, the silk may not sell for more than $4 a pound, but if well reeled it may bring $6 to $7, and even more, depending upon the demand at the time. It is also a peculiar fact, that of two reelers, each reeling half a pound of cocoons of the same quality, one will be able to obtain but 6 or 6½ ounces, and another will obtain 8 ounces.

The filaments of the cocoon are cemented together with a gum, and to dissolve this gum requires the aid of hot water. The cocoons are placed, from 6 to 10 at a time, in a basin of hot water, and sunk by the aid of a whisk broom below the surface, where they are allowed to remain from two to three minutes. This softens the gum and loosens the fibre; then, moving the whisk broom very lightly over the cocoons, the ends of the fibres will adhere to it and are easily found.

The ends of the fibres from each cocoon in the basin are then collected together to form one thread, which is passed through a guide eye and tied to one of the barbs of the reel, and the reeling begins.

The reels are usually turned by hand, although, occasionally, electric power is used. The reel must be so far away from the basin that the gum of the fibres has a chance to dry and cool before it passes onto the reel, otherwise the fibres would become firmly cemented together. It is also important that the reel should be moved at a certain uniform rate of speed. The whole operation is tedious and necessarily expensive, as five ounces of well-reeled silk represents about ten hours' labor by an expert reeler.

The reels are usually about 70 inches in circumference and have a traverse rod which properly distributes the thread over a surface two or three inches wide. So fine are the fibres which come from the cocoons that they are almost invisible to an inexperienced eye, and the reeler does not depend upon seeing them, but gets notice of a broken subdivision by discovering one of the cocoons at rest on the water, while the others are still in motion.

This rupture must be instantly repaired if a uniform thread of raw silk is to be obtained. A supply of cocoons is kept close at hand so that as fast as the fibre in one is exhausted, another is put in its place. The ends are joined by a dexterous movement of the reeler, who carries the end of a reserve cocoon fibre to a point just below the guide eye, where the natural gummy substance found on the silk, assisted by the movement of the reel, causes adherence to the main thread.

Thus no tying of knots takes place in a single fibre of the silk while reeling, although in case of a break in all of the fibres, which is not common, a fresh start must be made, and a small knot is made, hardly perceptible in the after stages which the silk passes through. The skeins of raw silk are reeled from one to several ounces, as desired, and, on being removed from the reels, are dried and neatly packed into books or bundles weighing from 5 to 10 pounds. These books are then packed and sold in bales containing 133 1-3 pounds each, which is the way in which the raw silk reaches this country.

SPINNING IN THE FACTORY.

On reaching the factories where the manufacture of this raw silk is carried on, the skeins are soaked in tepid soapsuds for several hours to soften the gum, after which they are placed on light "swifts" and wound off onto bobbins. This makes the raw silk soft and pliable and gives a certain lustre to it. These bobbins are placed upon pins projecting from the bobbin board of a doubling frame, and from two to ten threads, or even more, are drawn off collectively onto one bobbin, which is next placed upon a rapidly revolving spinning-frame spindle.

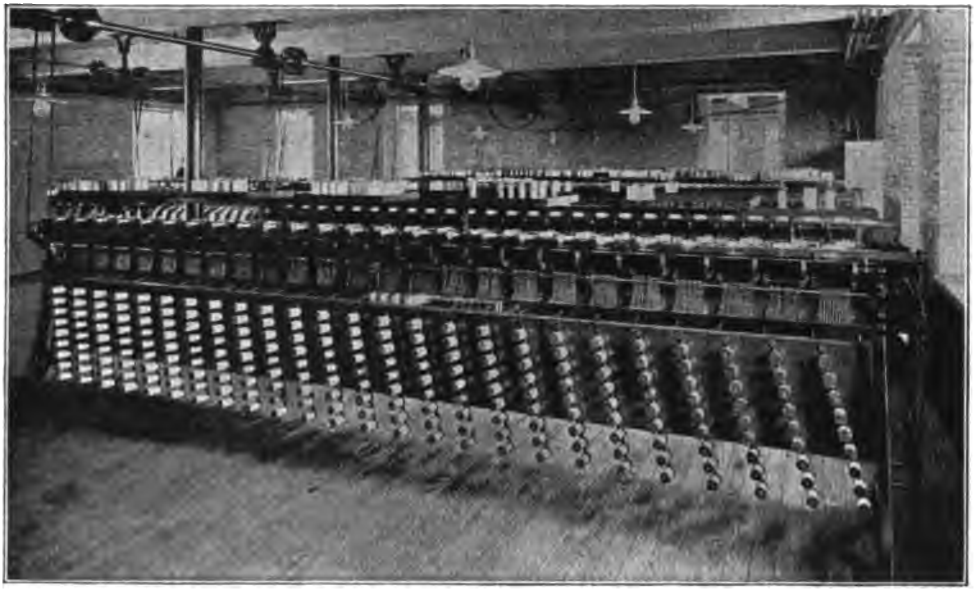
The thread is now drawn from the spindles and doubled and twisted, and for some purposes is again doubled and twisted, so that in an ordinary three-cord sewing silk it is quite possible to have 200 or even more of the original, gossamer threads which came from the cocoon, and the lightest grades contain from 75 to 80 of the fibres.

THE DRYING ROOMS.

Arrived at the factory, the skeins are sorted, graded, put in canvas bags, and then soaked in soapsuds to soften the gun. Afterwards the skeins are straightened out and hung on poles in a steam heated room as shown in this illustration. When dry, they are removed to the winding room.

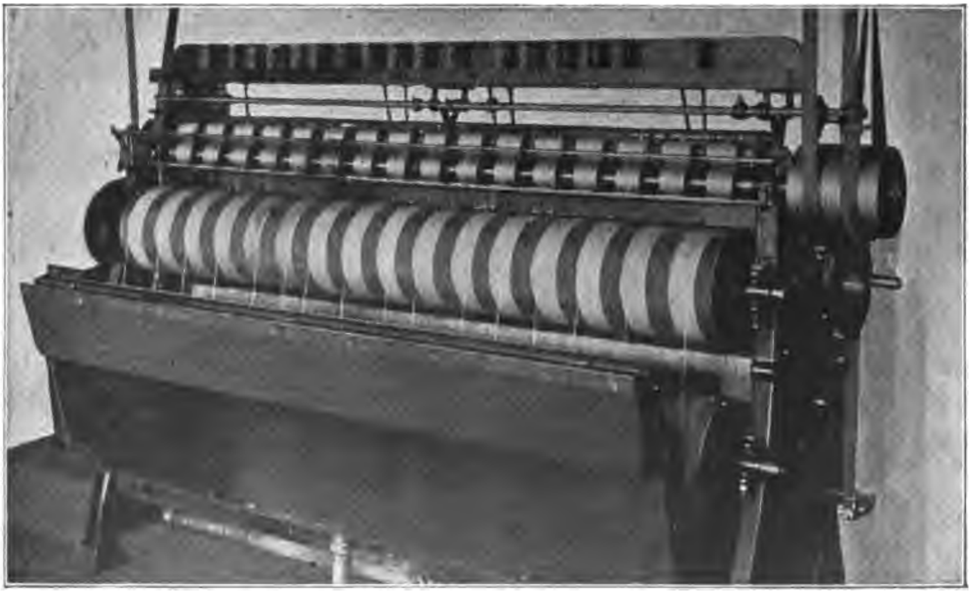
THE WINDING ROOM

You notice the skeins on the frames, the silk fiber is being wound off the frames on large spools or bobbins.



THE DOUBLING MACHINE.

These bobbins are next placed in position on the doubling machine. The purpose is to combine the threads from several bobbins into a single thread, according to the thickness desired.



THE WATER STRETCHER.

The next step required is to stretch the threads. The bobbins are placed in water and the silk is wound on the lower of these two rolls, from thence it passes to the upper roll, which turns faster and thus stretches the thread.

HOW COTTON CLOTH IS MADE

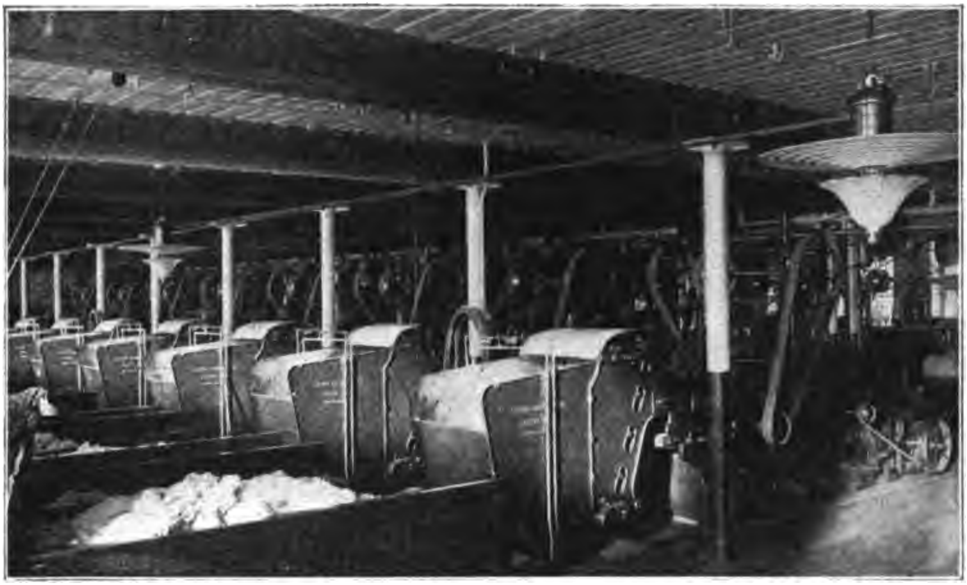
Cotton is one of the most valuable of Mother Nature's gifts to man. From its fiber we make clothing for the body and high explosives to protect our country in times of war. From the seeds we extract valuable oil, largely used in cooking and from it many grades of soap, candles, glycerine and other articles are manufactured. From the seeds also we manufacture a most nutritious food for animals, and a valuable fertilizer. So valuable has the seed become that it is bought and sold in markets as grain. It is asserted that cotton would be a valuable crop for the seed alone.

A FIELD OF COTTON IN BLOOM.

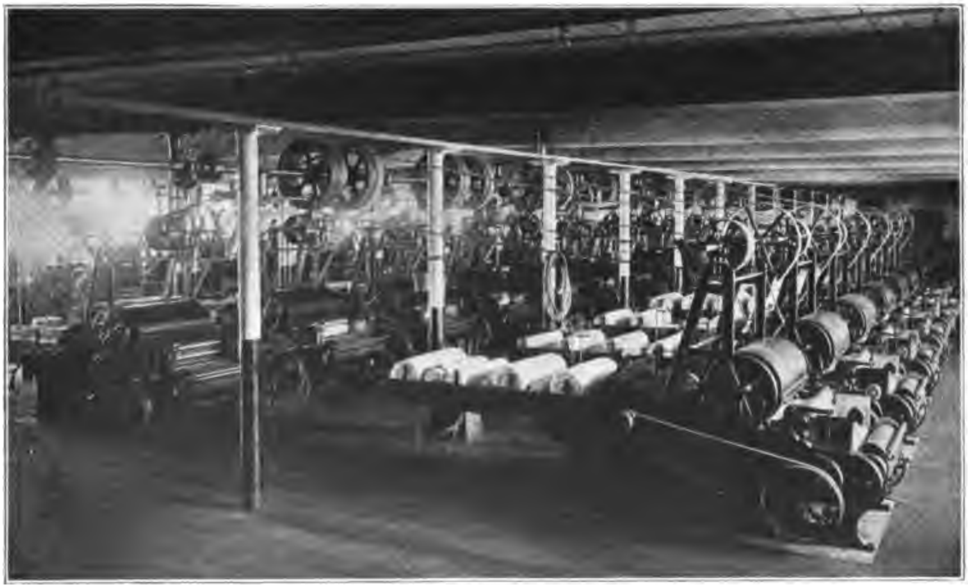
But the great value of cotton is the fiber from which we manufacture cotton fabrics. When one considers the immense amount of cotton material used for home purposes, its vast importance becomes manifest and its manufacture. This is one of the great industries of New England and our Southern States.

Cotton does well in comparatively limited sections, though widely scattered in warm temperate and torrid lands.

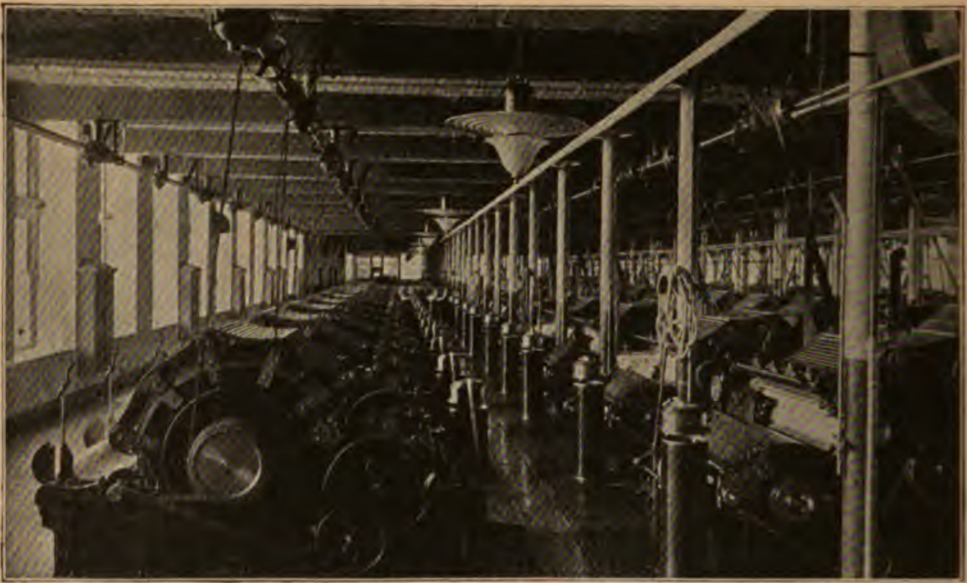
When the stand is good a field of cotton in bloom is a very pleasing sight. The plant itself is a small bush from two to four feet high, the lower branches more widely spreading than the upper ones. The flowers are white at first, but change to cream color and then are tinged with red. When the boll is fully grown it cracks and the seeds and fibrous lint burst forth. They are then gathered and taken to a cotton gin where the seeds are separated from the lint which is packed into bales and shipped to a cotton mill.



The compressed bale cotton is almost a solid mass of cotton, in it are imbedded pieces of leaves, seeds and much dust and dirt. It must be torn apart, cleaned, dusted, and arranged in a filing lap and different grades of cotton must be mixed. We have represented two of the machines of this process. Notice the

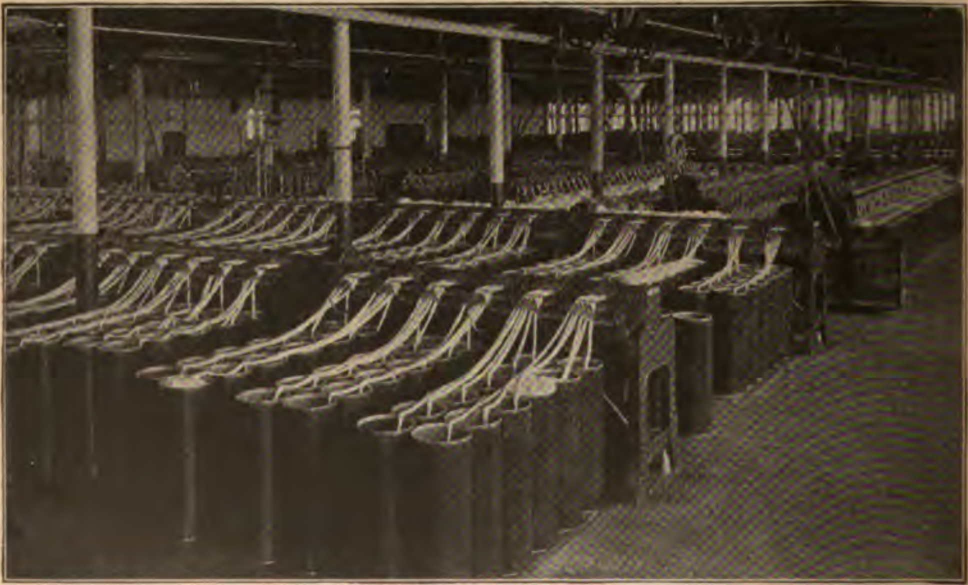


chunky dirty cotton of the first illustration, finally appears in rolled laps of clean, white filing cotton. Something like gigantic rolls of absorbent cotton that you buy in drug stores.

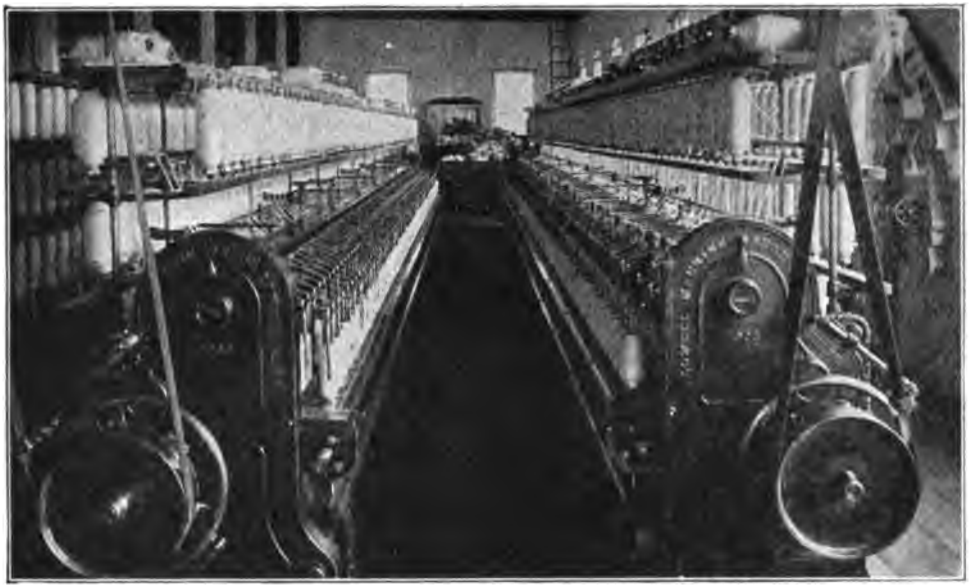


THE CARDER.

This line of machines is composed of carders. Notice a roll furnished by the foregoing process is being fed in at the left. The covering on the top of the machine and the revolving cylinder are covered with cloth in which are arranged projecting wires. The result is to arrange the fibers of the cotton in the rolled lap parallel. When that is done, they are in a tape form known as slivers, and are arranged in cans. In this drawing frame, six slivers are united in one and drawn out into a cord, but not yet twisted.

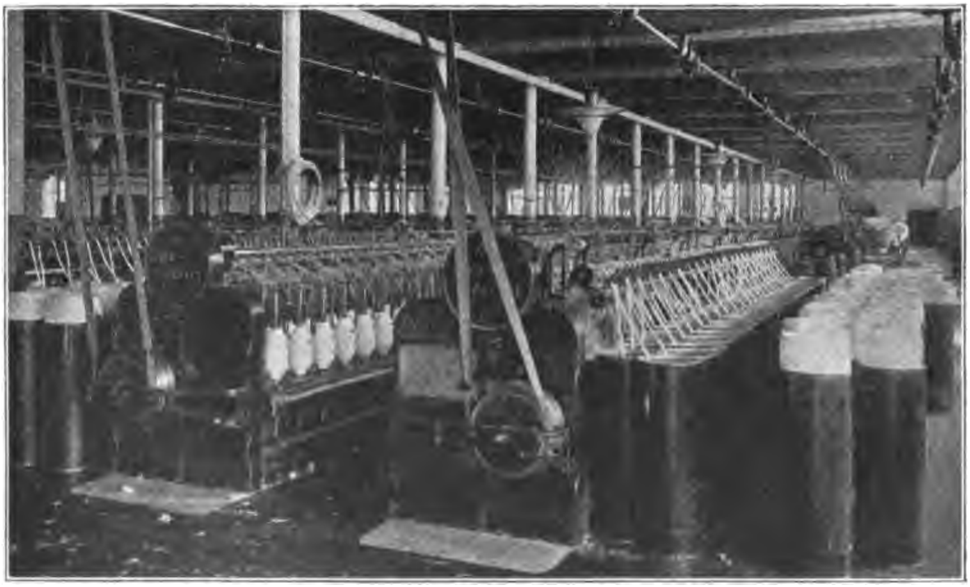


DRAWING FRAMES.

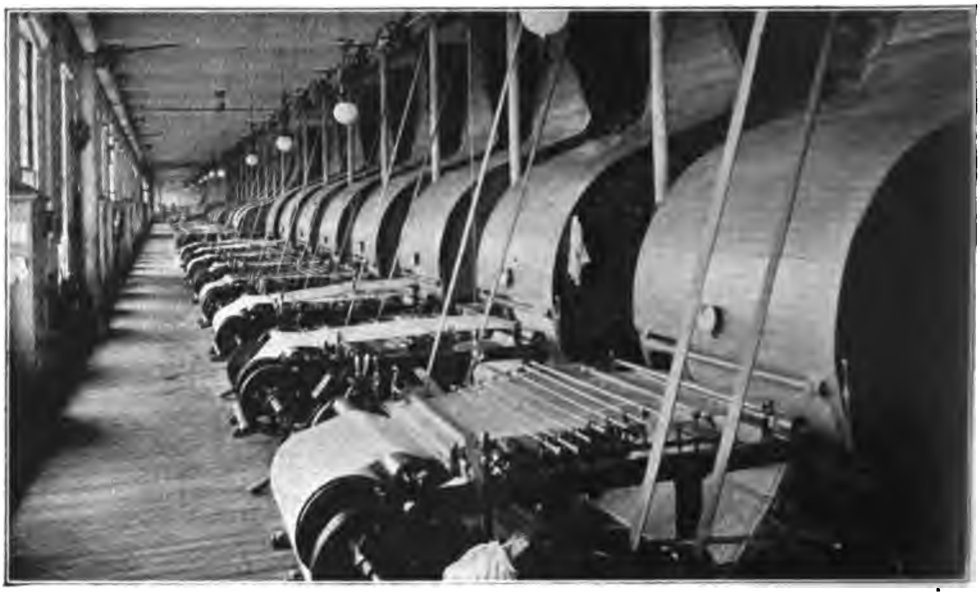


SLUBBING MACHINE.

Both of these machines continue the process begun in the drawing frame. The resulting sliver from the drawing frame is still further drawn out and wound on bobbins. Please notice them. It is now called a rove and in the roving frame it is again drawn out and slightly twisted, and in this machine two rovings are united in one. It is now ready for the spinning room.

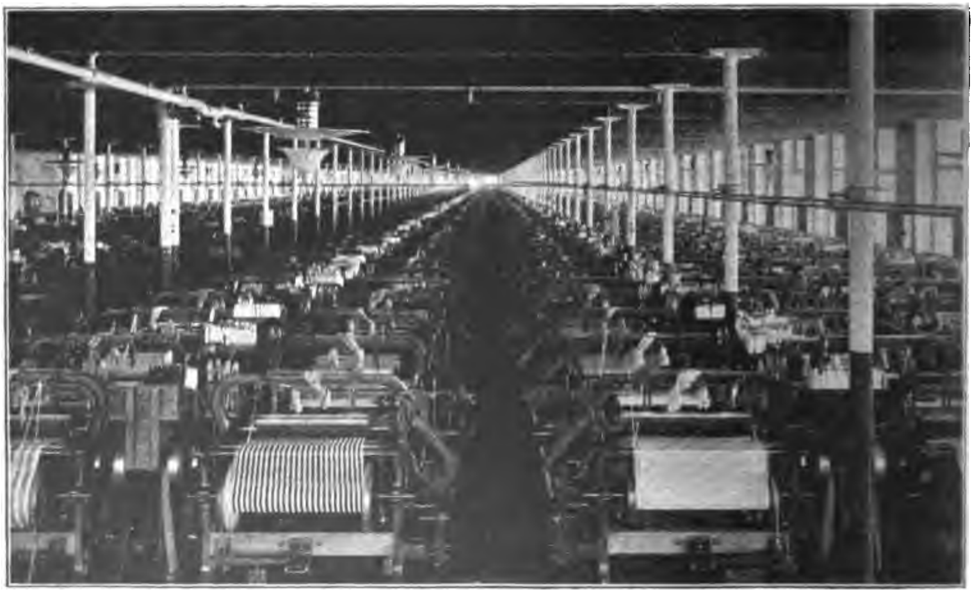


ROVING FRAMES.

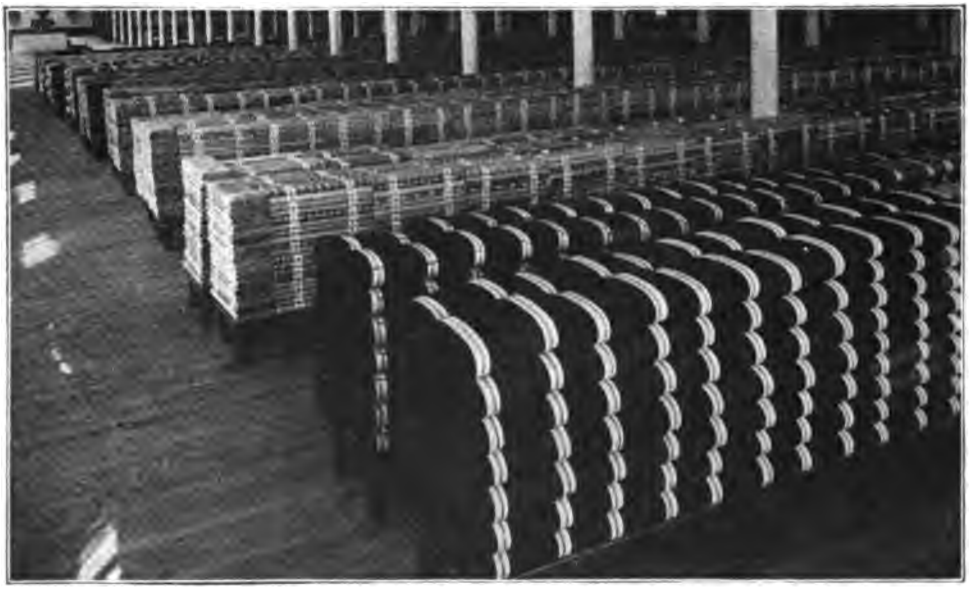


SIZING MACHINES.

Warp threads undergo a special process called sizing. A preparation in the nature of paste is applied to the threads, to strengthen them and to enable them to withstand friction. This is one of the last machines in the process. The warp has been dried in the box-like forms to the right.



Weaving is the final step, and here is illustrated the weaving room of a modern mill. This process is so complicated that it would require far more space than we can devote to it and would require many small illustrations to ake it clear. If you have a piece of cotton loth with a frazzled edge pick a piece part. The threads running lengthwise of he piece are the warp threads, those crossng them, now over, then under are the weft hreads. Recall the many steps that we ave now described by which the tangled mass of lint taken from the cotton bolls are finally arranged as warp threads. In these machines threads from other bobbins are being passed back and forth, over and under, shifting warp threads to form the cloth you hold in your hands. All this has constituted an interesting and instructive story. You have noticed what a marvelous part machinery is playing in this work.



FINISHED PRODUCT.

In this illustration, we have the finished product. Notice the bales of cloth, boxed and otherwise ready for shipment. And at Fall River, Massachusetts, "more than two miles of cotton cloth is produced every working minute." You can understand what such a statement implies.

There are a great many different names given to cotton cloths, but they may in general be divided into five classes—plain goods, twills, sateen, fancy cloth and jacquard fabrics. The cotton cloth in each of these classes varies and goes by different names. For instance in Plain Goods, the different kinds are lawn, nainsook, sheeting, mull, print cloth, madras. The difference lies in the number of threads in one inch of width, the fineness and the weave. The Twills have lines running diagonally and are used for linings mostly. The difference is in the weaving. Denim, largely used for overalls, belongs to the class of Twills. Sateen is used for dress linings, dresses and waists.

HOW PORCELAIN IS MADE

KILN.

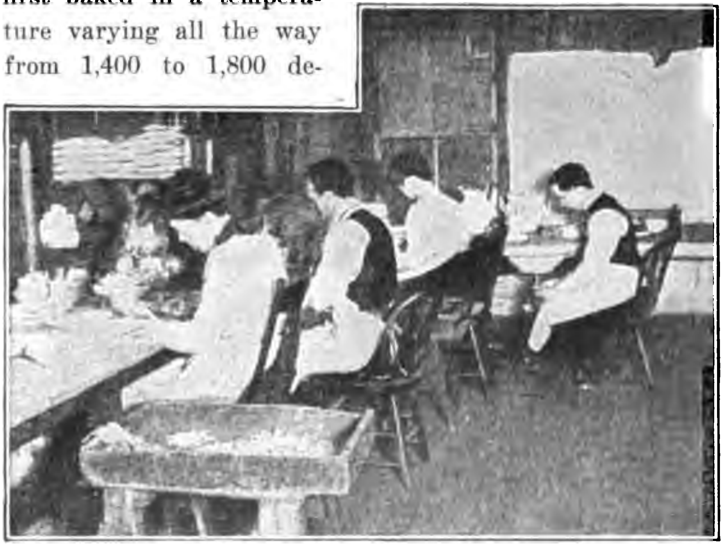
Porcelain ware, according to experts and connoisseurs, is brought to its highest development, artistically and mechanically, in the great imperial porcelain factory near Meissen, Saxony, the oldest in Germany. It was in these immense works that the secret of the Chinese and Japanese "crackleware" was discovered, and now crackleware is made in Saxony as well as in the Orient. The kaolin, or porcelain clay, from which the porcelain paste is made in the Meissen factory, comes partly from underground pits, and partly from open pits in the Saxon villages of Seilitz and Sornzig, and the feldspar comes from Norway.

CLAY DEPARTMENT.

The porcelain clay is first washed in a large wooden cylinder, which revolves horizontally, and then is run through a series of vats and channels, into which the heavier substances mixed with the clay are precipitated. The feldspar and quartz are separated from all impurities by means of hammers, and are mixed with the clay. The mixed mass is passed through filter presses and kneading machines, in which the great iron arms and knuckles blend the materials perfectly, and press out all the air bubbles. The mass then is rammed into barrels and stored for a long time, ten months at least, in order to give the clay plasticity and to make it more "workable." In the molding room, the plastic clay is formed into vases, urns, plaques, statuettes, busts, and other shapes, by modelers, who first make the clay model and then the plaster mold for those pieces which are duplicated and reduplicated, and are finished in plaster molds. Sometimes figures in groups are molded in separate pieces, and then fastened according to the model by means of the thin paste, or "slip," as it is called. The porous plaster of the mold sucks out all the moisture, leaving the molded objects quite dry.

A "bosser" puts on the finishing touches, correcting all faults in the plastic decorations. Then the articles are ready for the glazing. This is a very delicate and important process and one which requires much care and skill. They are first baked in a temperature varying all the way from 1,400 to 1,800 degrees Fahrenheit, which hardens them, and leaves them porous and very brittle. They then are ready to be painted or finished as white porcelain. In the glazing room each article is carefully dipped into the glaze bath, a milk white fluid, which is composed of kaolin, quartz, feldspar and limestone. As soon as the glazing mixture touches the porcelain all the colors painted on it by the artist disappear, for the glaze forms a powdery crust, which, however, fuses when exposed to a high heat, and the colors reappear. Those parts which are to remain unglazed are carefully covered with a preparation which protects the surface, and the porcelain is put into the kiln. The kilns are circular in form and are built in three stories. The articles in the lowest compartments are exposed to the highest heat, the temperature here reaching 2,912 degrees. The other stories are used to give the first baking.

DIPPERS GLAZING WARE.



HAND PAINTING AND GILDING.

Courtesy N. & W. Railway

MOVING A HEAVY TRAIN LOAD OF COAL.

Notice these electric locomotives doing the work of three Mallett steam engines. Scene on the Norfolk and Western Railway.

HOW COAL IS MINED

Ages ago, before men were living on the earth, Mother Nature stored in the earth great quantities of valuable ores, such as copper, iron and tin, vast supplies of oil, and perhaps like a prudent mother foreseeing the needs of men, she was very generous in the matter of fuel supplies, and deposited such enormous supplies of coal that even with the most prodigal use it will be centuries before it is exhausted, and by that time we will probably discover some substitute. But just now it is hard to see how we could get along without coal. Another interesting fact about coal is that in finishing off the coal making process, nature used different degrees of pressure and the result is different kinds of coal. Where the surface was subject to great pressure in mountain making—as in Eastern Pennsylvania—a very hard coal was produced, known as anthracite. In the great majority of cases, where the pressure was medium, bituminous coal was the result. In some of the western states there are great quantities of low grade coal—shall we say only half finished?—known as lignite.

COAL MINES.

There are many kinds of coal mines. In some places the coal exists in sheets or layers near the surface of the earth and it is only necessary to remove the thin layer of earth or stones to secure it. In other instances tunnels are driven into the sides of hills or mountains and the vein of coal followed up in this way. In the greater proportion of mines, however, the veins of coal are found at a considerable distance from the surface of the earth, and to reach them it is necessary to sink shafts, in some instances hundreds of feet. The walls of these shafts are lined with wood, masonry or iron plate.

Swift elevators to hoist coal and workmen go up and down this shaft. Generally there is another shaft for ventilation and safety at a distant part of the mine. At present the up-to-date mine is ventilated by blowing fresh air into it by electric fans. From the main shaft, the tunnels or roads branch out in all directions, and through them run tracks with cars drawn by compressed air engines, by electricity, or hauled by ropes or mules.

HOW THE COAL GOT INTO THE MINES.

In the long ago, thick layers of vegetable matter were formed; then subject to great heat and pressure. The hydrogen and oxygen which constituted the greater part of the plant substance was driven off and the carbon left behind. This change took place very gradually, through periods so long that we can only guess at their duration, but we know that many beds of coal were formed from layers of vegetable matter that were covered up many thousand years ago.

IMPROVEMENT IN MINING.

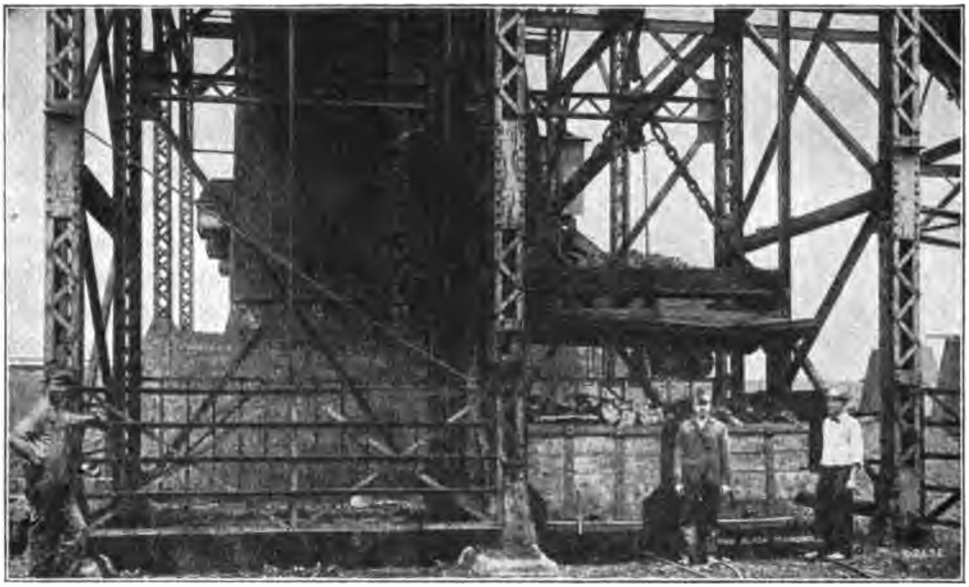
Improvements are constantly being effected in mining as in other labor fields. One of the greatest steps in advance has been effected by the quite general use of electricity. It is employed to run the high speed elevator, to provide power for hauling the cars, to light the passages, and to establish bell service from one part of the mine to another.

WASHING COAL.

For domestic use and certain other purposes washed coal is more satisfactory. By passing a thin layer of coal through a spray of water the dust and other impurities are removed. Not all coal is washed.

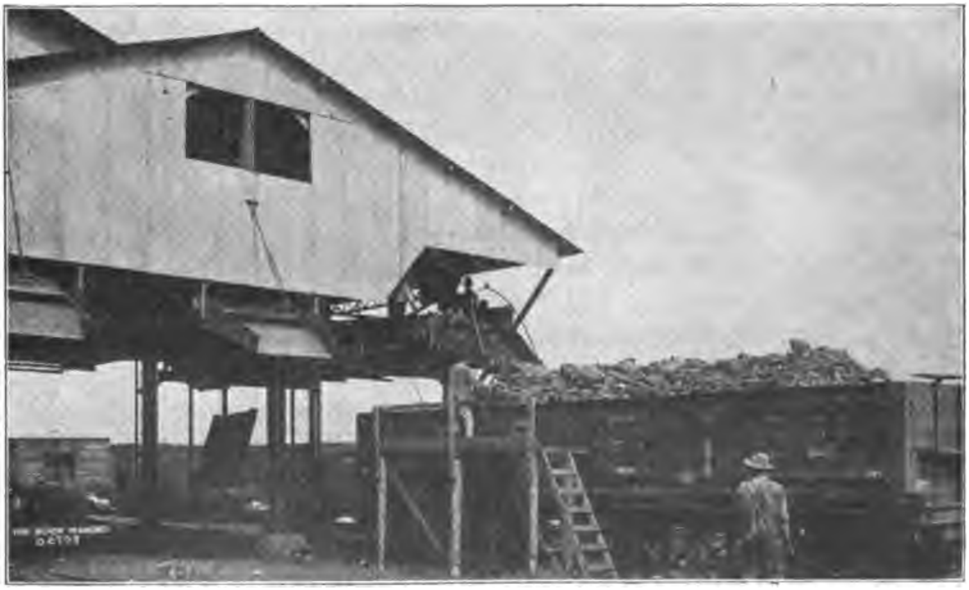
PICKING COAL.

Slate and other foreign articles are picked out, usually by hand. For this work some mines use spiral plate packers, which throw out the slate by centrifugal motion.



TOP OF SHAFT.

Two cars of coal have just been brought to the surface, while two more are being loaded on at the bottom. Safety gate prevents anyone falling in open shaft.



LOADING CARS.

After being washed, picked over and graded the coal is ready for loading on the cars, and is conveyed hither through chutes. If the coal is very soft and easily broken, long chutes which reach to the bottom of the car are used.

HOW HONEY IS SECURED

Bees furnish us honey and in the long ago, before men knew how to extract sugar from cane and beets or from trees, they depended to a large extent on the bee to furnish them a supply of honey. And so it is that the bee is often mentioned in early writings. Bees don't make honey, they gather and store it. As if to provide for the wants of her children men, before they could learn the secret of sugar making, Mother Nature fitted bees to live together in well ordered communities consisting of many thousand bees gathered in rock cavities or hollow trees where the results of their combined labor, in extracting honey from flowers, are stored away, in a cunningly arranged collection of cells that we call a comb. This community of workers is, in a sense, presided over by a queen mother. But after all the community is a true republic.

A HARD WORKER.

The bee is one of the busiest of the world's workers and has long been the symbol of industry and husbandry. From these traits we get our expression of "as busy as a bee," while from its restless habits comes the saying of "having a bee in one's bonnet." "Quilting bees" and "husking bees," the picturesque ways in which our grandfathers and grandmothers got together for a frolic and to work for the benefit of one, derived their names from the community habits of the bee. In the summer time bees literally work themselves to death, gathering honey, nursing young bees, making wax and comb, ventilating the hives, etc.

HOW BEES DEFEND THEMSELVES.

Mother Nature generally makes some arrangements for defense on the part of her children. So she has armed bees with a sting, and most boys know by experience that a good healthy bee and its sting is entitled to most respectful consideration. Honey bee's cousins—bumble bees and wasps—are good fighters. Especially wasps, and if you are so unfortunate as to run into a colony of wasps you had better retreat as rapidly as possible. When honey bees get down to business in defense of their stores, they generally do such a thorough job that they leave the sting in the quivering flesh.

THE WORKERS.

There are three kinds of bees in the hives, the queen, the workers, and the drones. The queen is literally the mother of the hive, and she does a most wonderful egg business. The drones are simply intended to give life and vivacity to the hive for a brief period. Our interest centers on the workers. These little fellows are constantly working, making comb, ventilating the hive, nursing the baby bees, and when they have nothing else to do, they fly out after honey. Life seems just one round of labor for them.

The title of queen has been given to the female bee which normally lays all the eggs of the colony, under the supposition that she governs the colony and directs its activities. This we now know to be an error, but the name still remains. Her one duty in life is that of egg-laying. She is most carefully watched over by the workers, and is constantly surrounded by a circle of attendants who feed her and touch her with their antennæ; but she in no way dictates what shall take place in the hive.

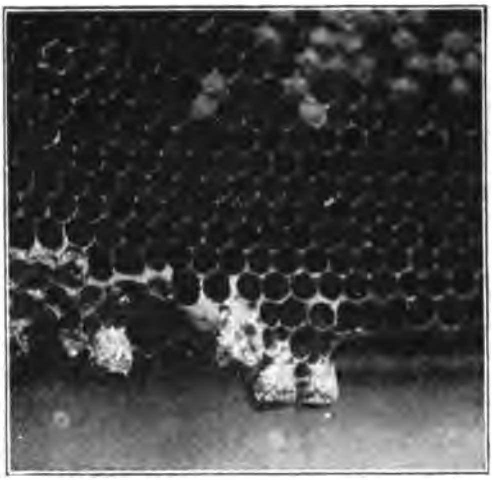
THE VALUE OF HONEY.

In these days of high cost of living, it is instructive and interesting to figure out the comparative food values of various articles ordinarily used. It has been determined by many careful experiments that honey is one of the cheapest of foods. A pound of honey contains as much nutriment as two pounds of beefsteak, two quarts of milk, two dozen eggs, sixteen oranges, or twelve bananas.

Evidently the queen mother is a very important personage. Her importance commences before she is hatched from an egg and is indicated by the food given her. The cell in which she is hatched is larger than the ordinary cell and the food on which she is fed is abundant and the workers are on the watch and don't allow a queen to develop until they are about to swarm, that is, sent out to form a new hive.

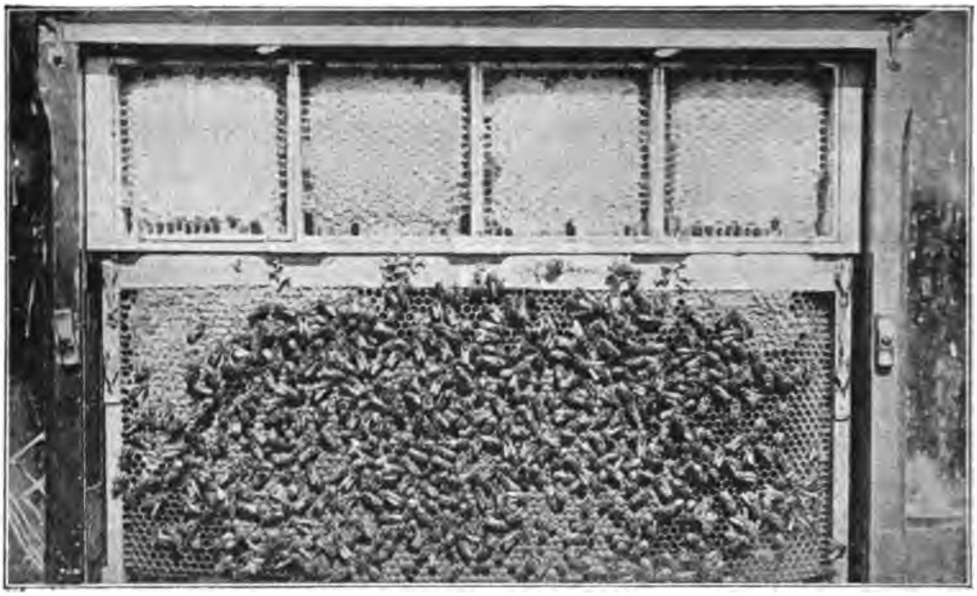
THE SWARM.

Whether the hive holds a sort of family council or not, we cannot tell, but certain it is that various signs foretell the coming flight. One is a sort of farewell feast. The bees gorge themselves with honey and, like most hungry boys and girls, they are good natured when they have had a good dinnner and so permit their keeper to take liberties with them and do not resent it by stinging. It is always the old queen that leads the new swarm. It would never do to entrust such a particular piece of work to a young and giddy queen. The old queen has a plentiful following for thousands of the old workers follow their leader.



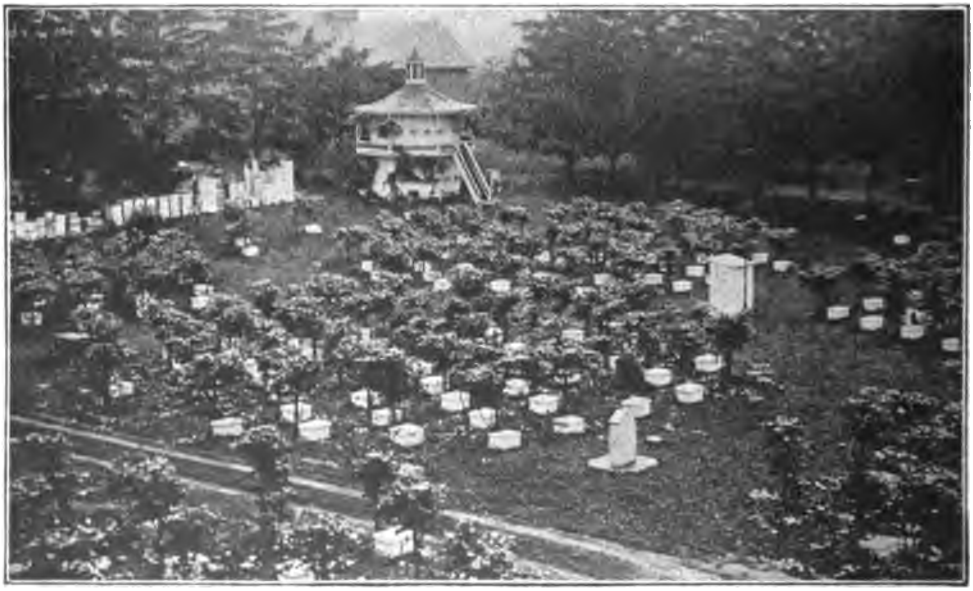
THE QUEEN CELLS.

Of course, the bee keeper does not care to lose such a quantity of bees and he has a new home ready for them and uses various means to induce them to settle therein. In earlier days, before we knew as much about handling bees as we have now learned, the swarm often became a run-away swarm and disappeared in the forest to take lodgment in some bee tree to the delight of various animals that knew how to get their share of the honey.



THE APIARY.

This is an observation hive. It is largely made of glass and the bees' method of work can be studied through its sides. It must however be closed up most of the time, or the bees will go on a strike.



It pays to place the hives amid pleasant surroundings. In this successful apiary, a trellis of grape vines is placed before each hive. Such a location is shady in summer and open to sunshine in fall and spring.

HELPING THE BEES.

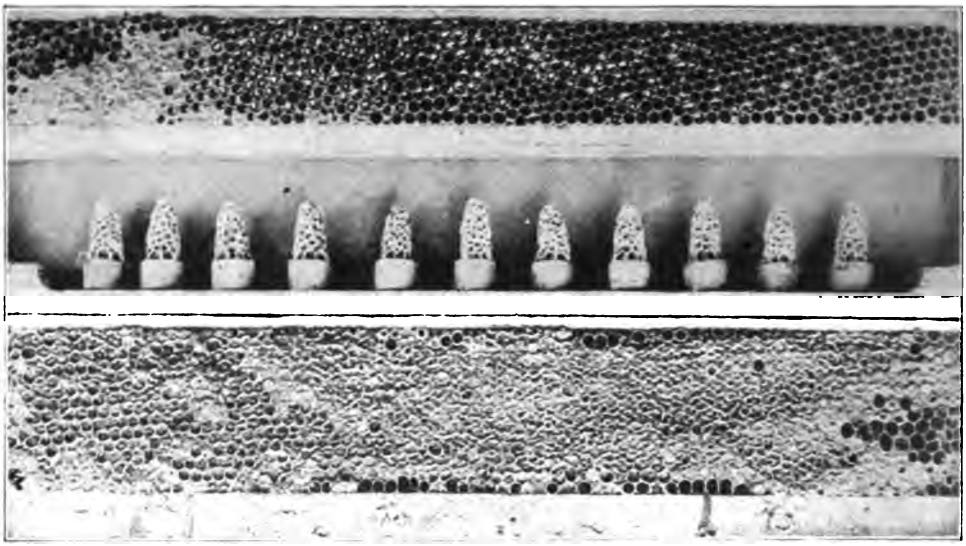
In this illustration is shown one of the ways in which bees accept the co-operation of men. In a state of nature bees most industriously set to work to make new combs to fill with honey when they have finished work in one case. But this requires time and energy which the bee could more profitably use in extracting honey, work in which man cannot help him. It requires several pounds of honey to produce one pound of wax. Therefore the bees are given partially completed combs, or second hand combs, or even artificial combs. At any rate, the bees accept the situation and complete, repair, or make over the combs furnished them, and turn cheerfully to the work of filling them with honey.

THE COMPLETED COMB.

Here we see a piece of honey comb which just fills a little box that we provided the bees who had no idea they were working to make money for their owner, but thought they were storing up honey for their own use, that is, if they thought anything about it at all. That honey comb is a marvelous construction. You will learn later on that an engineer could not make a better disposal of the space at his command. It has required the work of several bees to fill a cell, or we had better say having begun to fill a cell, they complete that one before taking up another. Then if they intend to keep the honey some time, they sterilize it by an exceedingly minute drop of chemical and neatly put on a cap of wax.

SMOKING THE BEES.

In this illustration, the man for some reason wishes to examine the inside of the hive. Perhaps he wishes to take out some honey. Bees have a decided objection to smoke, and when it is blown among them they gorge themselves on honey and can then be handled with comparative ease.



BEES FOR SALE.

Bees are often raised to sell just as any fancy stock. The raising of queen bees is an important industry. The bee raisers make artificial queen cells in which the eggs result in queens.

GETTING READY FOR SHIPMENT.

But bees themselves are also sold. And even when the queen is shipped some workers must be put in the cage with her. Notice how the bees are being bumped off the comb into a box for shipment.

MAKING MONEY AT THE MINT

The United States mint was established by act of Congress April 2, 1792.

COPPER CENTS, FIRST MONEY COINED.

The first money, copper cents, was coined in 1793 in the building erected by the government on the east side of Seventh street, near Market street, Philadelphia. The first director of the mint was David Rittenhouse, LL. D., and among his successors have been Elias Boudinot, Robert Paterson, James Ross Snowden, James Pollock, Dr. Linderman and Col. Snowden.

SILVER DOLLARS AND GOLD EAGLES CAME NEXT.

Silver dollars were the second money made, in 1794, and next gold eagles, in 1795. The first machinery, as well as metal used, came from England, and up to 1816 all work was done by horse or hand power. During five years of the mint's existence, work has been suspended owing to the prevalence of disease in the city. The present mint, on Chestnut street, near Broad, built of white marble, in the Grecian style, was finished in 1833.

NO GOLD EAGLES COINED FOR 33 YEARS.

No eagles were coined from 1805 to 1837, inclusive.

PERIODS OF CESSATION IN CERTAIN COINAGES.

No half eagles were coined in 1816 or 1817; no quarter eagles before 1796, nor in 1800 or 1801, nor from 1809 to 1820, or in 1822, 1823, 1828 or 1841; no dollars from 1806 to 1838, except 1,000 in 1836; no half dollars from 1797 to 1800, nor in 1815; no quarters before 1796, none from 1798 to 1803, none from 1808 to 1814, and none in 1817-24-26-29 and 1830; no half dimes in 1798, 1799, 1804 and 1806 to 1828; no cents in 1815, a few specimens in 1823; no half cents in 1798, 1801, 1812 to 1824, 1827 to 1830, 1834, 1837 and 1840. A few half cents were struck every year from 1840 to 1857. The first $3 pieces were made in 1854.

The silver dollar coinage of 412½ grains, the 5-cent and 3-cent silver pieces and the bronze 2-cent piece ceased April 1, 1873.

SAN FRANCISCO, DENVER AND CARSON CITY MINTS.

The mints at Carson and San Francisco coin gold and silver only, and the Denver mint is confined to assaying and refining.

THE WEIGHING ROOM.

The first process of the mint is in the weighing room where all precious metal—gold from California, Georgia, Montana and Nova Scotia, and silver from Nevada and most of the world—is weighed. Here come, also, family plate and bricks of silver, copper from Lake Superior and nickel from Pennsylvania. Tons of silver bricks are here, weighing from 100 to 150 pounds each.

The largest weight used in the weighing room is 6,000 ounces; the smallest weight used in the mint is in the assaying room and weighs 1-1300 of an ounce.

THE DEPOSIT MELTING ROOM.

The metals for coining, including gold dust, grains of gold and crystalline lumps, next go to the deposit melting room, where they are placed in pots, and with a suitable flux, are melted and molded.

ASSAYING.

Bits are cut off for assaying before the metal goes to the refiner and melter. For assaying, the small bit of gold is taken to the assayer's room, a dark department, with crucibles, kettles and pans. It is put into a black lead pot, melted and fluxed, stirred up to make a complete mixture and then cooled and rolled out. Then half a gramme is weighed, which is stamped 1000, and all the weights thereafter used are decimals of this, to the ten thousandth part.

Silver for the alloying is next added, and then lead for the cupellation; the whole is cupelled until the base metals are fused, the remaining bullion is beaten in a spiral, the silver dissolved out and the remaining gold determined by weight. Iron molds are used in the melting room, which are previously greased to prevent sticking and all the gold and silver used in the mint, in molten mass, are poured into these and speedily cooled. The long, thin, rich-colored bars resulting are called ingots.

THE ROLLING ROOM.

From the melting room the bars go to the rolling room, where 200 per hour pass through the mighty revolving jaws of each pair of rollers, coming forth with the exact thickness of a coin.

In the same room with the rollers are nine cutting presses, which, with a continual snap, snap, bite out 225 planchets of plain coin pieces in a minute. These planchets are taken in boxes to the annealing furnaces, for the hard treatment they have received makes them brittle. They are heated in the furnaces to a red heat and, having become soft and pliable as leather, are taken out to cool.

THE ADJUSTING ROOM.

The planchets then go to the adjusting room, where they are weighed and inspected. If too light, they are remelted; if a little too heavy, they are filed to the right weight; but if much too heavy, they, too, are remelted.

THE CLEANING ROOM.

From the adjusting room the planchets go to the cleaning room, where with acid and heat they are thoroughly cleaned, and then dried with sawdust and peanut-roaster contrivances. They are then milled and have their edges turned up, after which they go to the presses.

THE PRESSES.

The presses are ten massive monsters, each capable of turning out over 100 coins per minute. The amount of pressure required to make a perfect coin is from 20 to 80 tons, according to the size of the coin. The planchets are put in a brass tube, and with each impress are caught in two iron arms and placed on the lower die, which is in the bed of the press, corresponding to the upper die, and by the coming together of these two dies the coins are struck. As the planchet rests on the lower die, the upper descends and impresses it, and the two arms instantly catch the coin struck and throw it into a box beneath.

NOW LEGAL COIN. THE COUNTING.

At this moment it is a legal coin. The coins are then taken from the boxes and placed on grooved counting boards, similar to washboards, which hold a certain number of coins. After this count they are poured into a drawer, out of which they are again counted, and placed in bags, ready for their mission of happiness or wretchedness.

HOW WHITE LEAD IS MADE

A new process for the manufacture of white lead has been discovered by a chemist and mining engineer of Boston. This new process is what is known as the "electrolytic," and, judging from recent tests, it will be able to compete with the best now in operation.

In the "electrolytic" process, a solution of sodium nitrate contained in two compartment cells, separated by porous diaphragms, is decomposed by an electric current. The electrodes in these cells are lead and copper. At the positive electrode, lead nitrate is formed and dissolved, and sodium hydroxide collects, and is dissolved at the copper pole. These solutions are drawn off and mixed in the proper proportions, and sodium nitrate is reproduced and lead hydrate precipitated in the form of an amorphous powder. A solution of sodium carbonate is then mixed with the lead hydrate, when lead carbonate (white lead) and hydrate sodium are formed. This sodium hydrate may again be converted into the carbonate by passing carbonic acid into it.

The sodium carbonate may be used again for the conversion of more lead hydrate into white lead. The nitrate reproduced in the second operation may be again used as in the first, and there is but a slight loss in the repeated service of these two agents. During the past year, tests of the electrolytic pigment have been made, and in each instance it has proven itself equal to that manufactured by the Dutch. The new process is rapid, and requires only a small plant for a considerable output. It yields a good paint, with very little labor.

AN OLD INDUSTRY.

The manufacture of white lead, which is the most important of all pigments, is a very old industry, the native carbonate, *cerussie*, having been used by the Romans. But as this mineral is restricted in its distribution, the artificial product was in time brought into use.

THE DUTCH PROCESS.

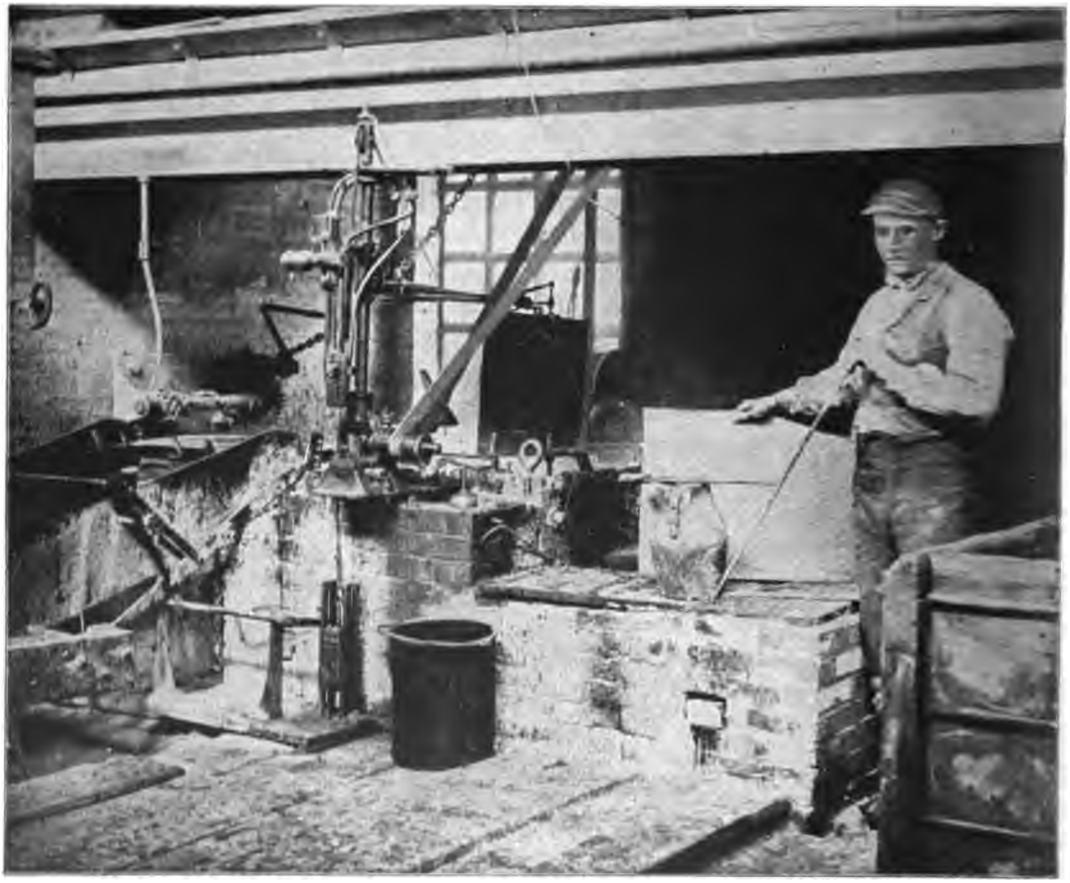
The so-called Dutch process of making white lead is the oldest known, reference being made to it as far back as 1622. With a few modifications, it is still in use, and yields a product which, for many purposes, is preferred by painters to the lead manufactured by the numerous newer processes. It usually has more covering power, and a better color. The method consists in exposing sheet lead to the direct action of moisture, acetic acid vapors and carbon dioxide. Two other modes of manufacture are generally in vogue—the German, or Chamber process; and the French, or Thenard's process.

White lead, however made, is principally used in making paint. Used by itself, it makes white paint but it may be colored or tinted to many different hues by adding suitable color pigments. These color pigments are of many kinds and are derived from many different sources. The vegetable kingdom is represented as well as the mineral and animal kingdoms. Linseed oil is derived from the vegetable kingdom. This is also true of a few of the pigments. A very important instance is a beautiful rich brown called "Vandyke Brown," made from decayed vegetation found in swampy districts.

TIN-MAKING IN THE TWENTIETH CENTURY

Originally the method of tinning plates was the simple expedient of dipping them in a bath of molten tin and allowing the surplus metal to drain off; but about thirty or forty years ago, a Mr. Morewood, of South Wales, Great Britain, designed a tinning machine which has since revolutionized the tinning process. The system consists of placing at the surface of the pot a pair of very carefully turned steel rods, which seize the plate as it comes up and roll off the surplus tin, leaving a smooth and even coating of the metal.

Even this system has been improved, and to-day the rolls are submerged inside the tinning pots in the hot metal and oil baths, and as the plates pass through, while the coating process is going on, it leaves a uniform coating and a highly polished surface. In the manufacture of high-grade

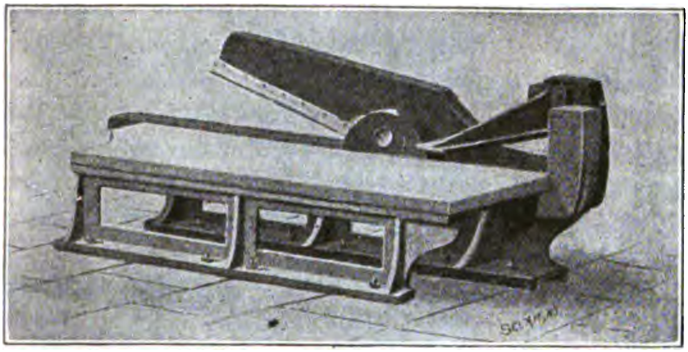


By courtesy of the Scientific American.

TINNING MACHINE.

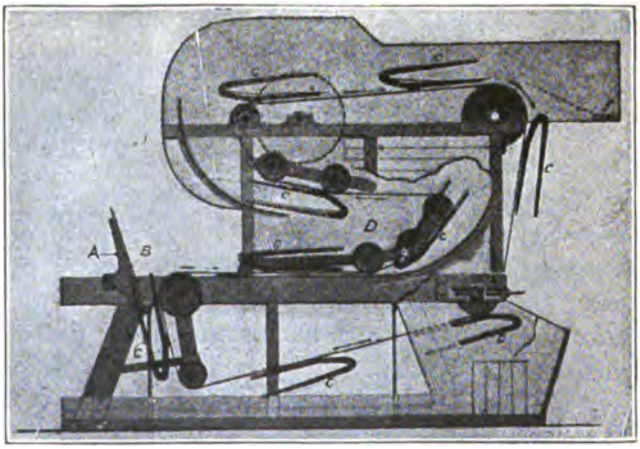
With Bennett Magnetic Catcher for removing tinned plates as they come from the rolls.

roofing tin, the hand process of dipping is still maintained.



THE CUTTING AND DOUBLING SHEARS.

In this hand-dipping process, known as the "MF Style," the plates pass through four or five different pots filled respectively with metal or palm oil. The plates made by this process resist attacks of the atmosphere more thoroughly than plates made in the "coke" tinning process. Recently, a new method of finishing has been introduced. In this method, the plates after coming out of the last old-style of "MF." tinning bath, are immersed immediately in an oily substance, the temperature of which is below the melting point of the coating metal, and an instantaneous and uniform settling of the coating metal is thereby effected on all parts of the sheets alike.



THE BRANNER.

A sectional illustration of a modern tinning machine is herewith given, which shows very clearly its construction. The heavy cast-iron tin pot is carried in a brick setting, and the tin is kept molten by a furnace below the pot. In the bottom of the pot is about 14 inches of the molten tin, and above this on the discharging side are 12 inches of palm oil. The black plate is introduced into the tin pot through the hopper (A). This hopper holds a chemical fluid, the weight of which is less in specific gravity than the molten tin, and which in combination with the tin and iron, causes a galvanic action by which the iron and tin are quickly and thoroughly amalgamated. The tinner pushes the plate downward with a pair of tongs over the curved guide bars until it is seized by the first pair of rolls known as the "feed rolls" marked (B) in the picture. By these it is drawn through the molten tin into the upward curved hopper (C), in which are running two pairs of rolls (D D). The top pair is partly visible and partly immersed in the palm oil which covers the tin on this side of the machine. These rolls are held suspended in a machine frame and are regulated by means of screws.

HOW MATCHES ARE MADE

Seeing that fire has been employed by man since prehistoric days, one would expect that easy means of obtaining it would have been devised in the early ages. We find, however, that until the beginning of the nineteenth century nothing in the nature of a match was available, and the crudest methods were still in use. We know from Virgil that in the reign of the Emperor Titus fire was obtained by rubbing decayed wood with a roll of sulphur between two stones, but it is not till Saxon times that we have evidence of the use of the tinder box with its flint and steel. That this latter was still regarded as something remarkable, as late as the fifteenth century, is proved by its representation in the collar of the Order of the Golden Fleece, which was founded in 1429. Burning glasses had, of course, been employed from the most primitive times, but one can imagine the despair of an early Briton who had to wait for a sunny day before he could boil his kettle.

Incredible as it may seem, it was not a time well within the memory of many people living to-day that matches in anything approaching the form now familiar were offered to the public. The way for their manufacture had been prepared by two discoveries; one by a German who isolated phosphorus in 1669; the other by a Frenchman who produced chlorate of potash in 1786. From this latter date the production of fire was much facilitated, and a few years before Queen Victoria came to the throne, John Walker—a chemist of Stockton-on-Tees—produced the first friction matches of which there is any certain record. These, called "Congreves," were sold in boxes of fifty for 2/6, and their success soon led others to experiment in match manufacture, so that improvements were rapidly invented and factories sprang up in all parts of the country.

These familiar objects, apart from their luxurious use by smokers, are the indispensable servants of mankind from the moment of rising in the morning till the household is wrapped in sleep, and it is to them we turn when disturbed in the hours of darkness.

INGENIOUS MATCH MAKING MACHINERY.

Twelve thousand a minute, or 7,200,000 in a day of 10 working hours, is the record of the latest machine for making matches. One of these machines covers not to exceed 300 square feet of space, but it works with such rapidity that it has reduced the cost of production one-half. The machine is entirely automatic, and from the time a match enters as a block of wood until it emerges, ready for packing, it is untouched by human hands.

Cork pine is used for the match timber and it is purchased in two-inch planks. These are well seasoned, cut into match lengths, and fed into the machinery by means of a block conveyor. The blocks pass under a battery of small knives. These knives are 48 in number and each one gouges down into the wood lengthwise with the grain and comes up bearing a match splint. Every knife cuts 250 splints a minute, and as each piece of wood is torn away, the upper end is forced into a steel bar, which has a number of perforations, each slightly smaller than the match.

The bar, which securely grips the splint,

THE MATCH MACHINE.

s a link that is part of an endless belt 500 eet in length, which takes fifty minutes to nake a complete circuit. This belt carries the matches through a paraffin bath shortly after they come from the knives. The bath, or dip, makes them more inflammable. The paraffin is kept in a molten state by an ingenious contrivance which drains off the cooled liquid and adds more at a higher temperature.

The greater portion of the matches made have two tips. This tipping is accomplished by two rollers, the phosphorous friction material being put on by one and the chlorate of potash composition by the other. Both of these substances are kept melted in a reservoir and the rolls revolve in them at exactly the same rate of speed that the conveying belt travels, and as the match wood lightly touches the roll it is tipped with a small quantity of the igniting composition. Considerable time elapses between the dips, and the belt turns in various positions on its journey in order that each tip may dry to a regular shape. The extreme length of the belt is to allow the matches to become thoroughly dry before being packed.

At the end of the circuit each completed match is pushed from its holding bar by pins which fit each perforation in the latter. As they fall on a shelf an endless chain conveys them to the packing table, where they are placed in boxes, wrapped and sent to

MACHINE THAT MAKES THE BOXES.

the shipping room. Only five packing girls and two helpers are required to tend a machine doing the work which in the older processes required twenty-five persons, with a much smaller output.

The operation of making the boxes is one that is almost as interesting as making the match itself. The boxboard comes to the factory in large rolls and is there cut into sizes required for the various matches. It is then fed into the box machine and is stamped with the name of the company, cut to shape, and folded. The strip of sandpaper on each side is made by passing a glue-covered roller along the box and then throwing sand up against it.

In making safety matches, the process is different. There is none of the common phosphorus on the tip of the match, but the phosphorus is placed on the rubbing surface attached to the box itself, so that save under exceptional circumstances the match will not ignite, except on the box. The value of matches manufactured in the last census year was $11,353,138.

HOW PAINT IS MADE

As in many other respects, mechanical and inventive genuius have placed the United States at the head of all other nations in the manufacture of paint. In 1860 there was not a gallon of machine-made paint in the world. In the last census year there were 792 establishments in the United States, and the value of their products was $124,889,000. The demand is constantly increasing, the number of establishments increased one-third, and the value of the product three-fourths since the previous census.

There is not one person in thousands who knows how paint is made; not one in that number who knows that white lead is only one of several valuable bases, and that modern scientists have discovered other and equally good things to take the place of turpentine, which will soon be so scarce and high that were it exclusively used a gallon of paint would cost several times what it does now. This fact brings us to the first step in modern paint making—the work of the scientific department. Every big paint factory has its laboratory, which is equipped with as high-priced men and apparatus as the scientific department of a pharmaceutical concern. These men, over 1,000 of them in this country, are constantly at work striving to make their products better and at the same time cheaper, for in no other industry is competition more keen.

No sooner does one firm put out a new paint than it is analyzed by rival firms and the good qualities of the new paint are appropriated. To this department of a paint factory first comes all of the material which is to be used. In a big room is a miniature paint plant. There are miniature grinders and mixers in which only half a pint of paint can be made at a time. A certain batch of material comes in. It is first proved in this miniature factory, and if the chemists say it is all right, the material goes to the factory proper.

First the "base" is made. Perhaps half

a barrel of zinc white, white lead, or some other base substance is dumped into one of the big, churn-like mixers. To this is added linseed oil. Then the "churn" is set in action, and steel paddles begin whipping the mixture. This churn looks like a simple invention, yet it is a product of the last ten years in its perfected form, and its existence has lowered the price of paint a half. For an hour its paddles stir the base. Then this base, after coloring matter has been added to it (if a colored paint is desired), is slowly run into a grinding machine.

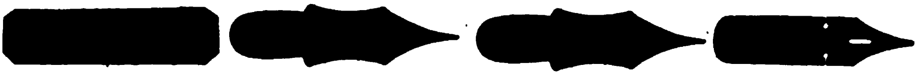
Paint is a combination consisting of finely ground pigments, suspended in a liquid menstruum, and the more finely the pigments are ground the better the paint. Because of this, it may be safely said that the mixer is the invention which made America the paint pail of the world. Imagine two huge steel grindstones fitted close one upon another, and revolving slowly in opposite directions, with tremendous pressure from both below and above, and you have a good idea of a grinding machine. Between the surfaces of these disks the paint slowly runs until the pigments are ground to microscopic fineness. When it oozes from between them it has been subjected to a grinding pressure of several tons, and is in its finished form. Linseed oil and turpentine or some other thinner is then added to it in other mixers, when it is ready to be placed in cans.

GRINDING PAINT.

HOW PENS ARE MADE

In the last census year five establishments in the United States produced $577,000 worth of steel pens; that means an almost incredible number of pens manufactured.

Good steel of a uniform grade and rich in carbon is the material used. The steel comes in sheets 19 inches wide and 5 feet long, which are cut into strips wide enough to permit of two pens being cut with their points interlapping. The steel is annealed to a light cherry red for a number of hours and then cooled gradually, when it is soft enough to bend easily. The scale is then removed by pickling the steel in a bath of diluted acid, and the strip is ready to be passed through the rolling mill. The number of times it must go through the mills depends upon how thin it is desired to roll it. Each strip is tested with a microchronometer gauge, and should it be too thick, it is again put through the mills. If too thin, it is laid aside for the production of a pen on which a thinner steel can be used. The steel then goes to the cutting room, where the pen blanks are cut out by machines. On one side of each blank there is a little dent, which is known as the "bit," and which is used as a guide in passing the metal through a number of succeeding operations.



The pens are pierced by machinery, some requiring but one piercing, others two or three, the latter being more expensive. From the piercing machine the pens go to the muffle room, where the blanks are annealed. Fifty or sixty gross of them are placed in each iron pot and heated and cooled just as was the strip steel. The name is then stamped on the blanks, and the pen is ready to be formed. Some pens have to be crushed, by which process a little wing of steel is bent under them.

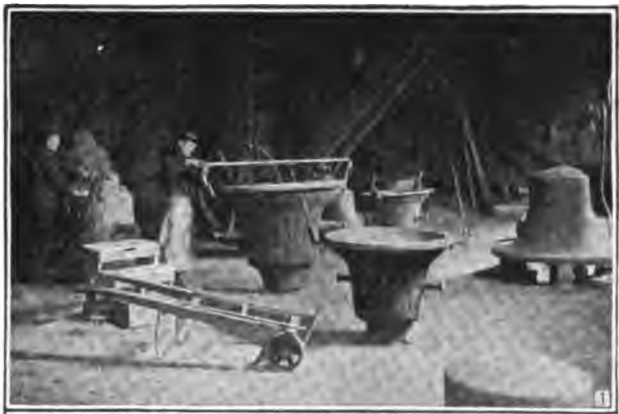
If the pen is still soft, it is necessary to take it to the muffle room and again heat it to a light cherry red and chill it suddenly. By this time the pen has become coated with an oxide, which is removed by scouring or by a shaking process, by which the roughness is gradually rubbed off. The next operation is grinding, some pens being ground twice, others three times, in some cases by hand and in others by automatic machinery.

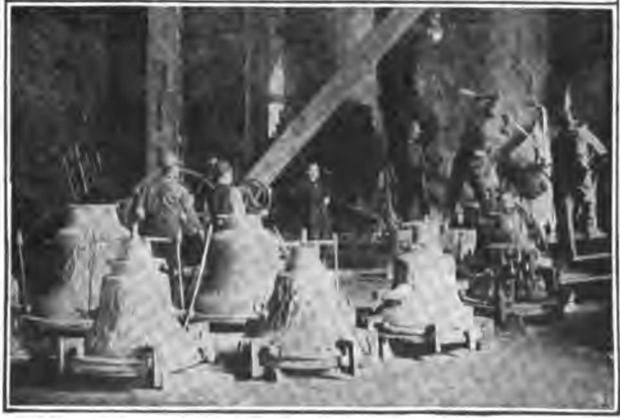
The pen next passes to the slitting room. This operation is a very delicate one, as the pen is now hard and brittle and the slit must be cut cleanly through the hard steel without damaging it in any way. After slitting, the pens go to the round room, where they are made perfectly round and smooth, so that no matter at what angle the pen is held the paper will be in a tangent to its surface and there will be no possibility of sticking or scratching. In order to preserve the pen and prevent it from rusting, a coat of lacquer is put on by means of machines.

The pens are now ready to go to the boxing room, where they are counted by ascertaining the weight. It will be found impossible to put a gross of pens in the box intended for them unless they are laid parallel. In order to do this quickly and easily, they are put in a half cylinder and shaken. This quickly places them in a parallel position, and by a very quick move of the operative they are dumped into the boxes, which are then ready to be labeled and packed.

HOW BELLS ARE MADE

Bells have been made from the earliest times, and serve many purposes. Many cathedral chimes are widely known and one of the most famous poems in the English language described the emotions aroused by differently sounding bells.





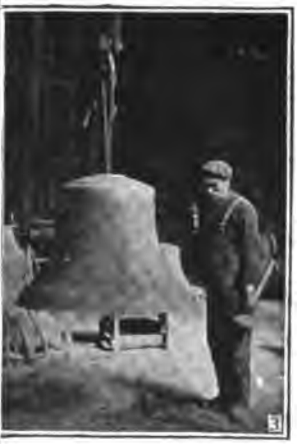


Fig. 1—Moulds. Fig. 2—Pouring the casting. Fig. 3—Testing a chime bell.

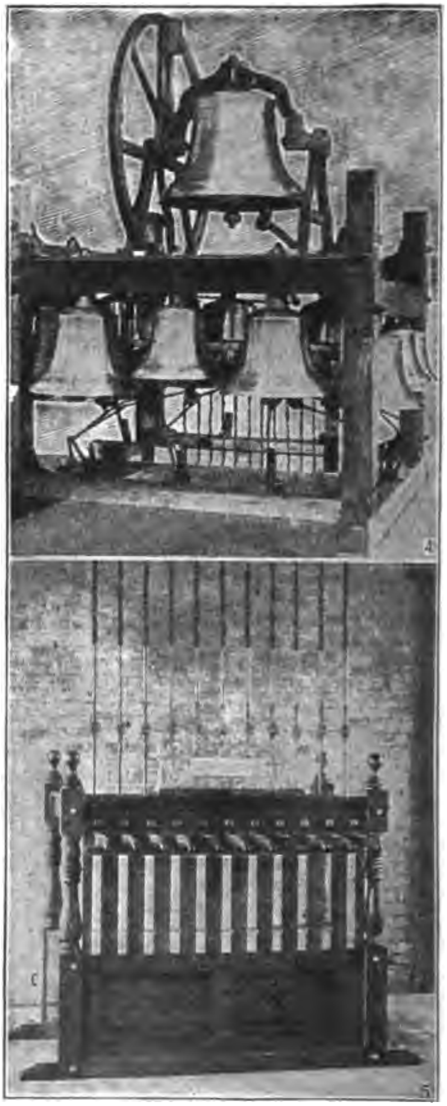
The bell-metal commonly used is an alloy composed of 80 parts copper and 20 parts tin, but every bell founder has his own variation of this formula, and in the product experience counts for a great deal. The metal is of a yellowish gray color, hard, brittle and sonorous; a fracture in it shows a fine grain. The copper used, where quality of tone is desired, must be commercially pure, as the presence of lead, even in minute quantities, affects the tone. The larger the proportion of copper in the alloy, the graver and deeper the tone of the bell, while by adding tin, zinc or iron a sharper tone results. Silver gives sweetness to the tone and many very old church bells contain a large amount of that metal. In some cases church bells have been cast from jewelry, coins and ornaments contributed by worshipers.

In the bell foundry the proportionate requirements for a bell are worked out mathematically, a suitable pattern board procured and a draft made which shows the inside diameter of the bell at the shoulder, just half the mouth diameter; the thickness of the bell through the sound-bow, that part struck by the clapper, one-fourteenth of the mouth diameter; the waist thickness, half the sound-bow; the shoulder thickness, a third of the sound-bow; and the height of the bell, about eleven times the thickness of the sound-bow.

According to this draft, two sweep-boards are fashioned, one called the core sweep and the other the case, or outer sweep. Two iron flasks are provided, also, called the case and the core. The case is an inch or two larger than the required finished mould and in it the outer shape is moulded. The core is an inch or two smaller than the required finished mould and on this the inner shape is moulded. These moulds are shown in Fig. 1, the cope or case with its wide part up and the core with its wide part down. The molds are each swept up with a rough loam coating on the casting surface and the outer mold receives an impression of the inscription which is to appear on the bell in raised letters, after which it is slicked over.

The molds are next closed and set around in order under a large crane ready for casting. Figure 2 shows how the metal is poured into the casting when prepared and also shows the molds ready for casting set under the big crane previously mentioned. The casting is usually done as early during the day as possible, so as to give plenty of time for the metal to slowly cool down by the next day, when the bells are removed from the molds to finishing cooling.

When the bells are intended for a peal or chime, they are lifted up and tested, as shown in Figure 3, to ascertain their accuracy of pitch, and if they are a little off, mechanical tuning brings them to standard. Bells for tower clocks or for fire alarm use, or for a church, or a school tower, used singly, are not tuned, as individuality of tone in such bells is desirable.



CHIMES AND KEYBOARD FOR PLAYING.

HOW RUBBER IS MADE TO-DAY

But two centuries have elapsed since rubber was known only as a curiosity; to-day it is in common use in nearly every industry and household.

THE PROCESS OF KNEADING.

The system by which crude rubber is brought down to merchantable condition, is a simple method of kneading by steam rollers. First the crude rubber is soaked in hot water for several hours. After this operation, it is cut up into pieces of convenient size and run through a washer, which is a machine equipped with heavy corrugated steel rollers. Here it passes through and through until it is crushed and mangled, all the time being washed clean of bugs and other impurities, that get into the rubber tree. The rubber is very sticky and after the washer has completed its work, one sees nothing but a sticky mass in long sheets. These are allowed to dry and then are run through heavier rollers.

THE PROCESS OF MIXING.

After this process the rubber is run through the "mixers," which consist of large hollow steel rollers having steam pipes inside of them, to furnish heat in the operation of mixing, and also a set of water pipes by which the rubber may be cooled when necessary. Through the rollers the rubber passes. So adhesive is it that it sticks fast to the rollers and has to be constantly cut off by means of a sharp knife, and thrown back, for another rolling. Great power is needed for this process because the sticky mixture retards the rollers. When the kneading is all but completed, a coloring compound is added to the mass to give it the tint desired in certain kinds of uses for which it is intended.

THE PROCESS OF COMPRESSING.

After this, the rubber is run through four polished steel rollers, one above the other, and here it gets its proper thickness. These rollers or "calenders" are used also for crushing the rubber into cotton ducking, for making rubber cloth, etc.

Manufactured rubber goods are made by this method of compression instead of by melting and pouring into molds.

THE PROCESS OF VULCANIZING.

Charles Goodyear discovered the process of vulcanizing rubber, a process which consists in changing the chemical composition of rubber by heat, whereby its sticky and

YOUNG RUBBER TREE.

elastic properties are removed and the rubber is given greater durability. This process consists in submitting the rubber to a great pressure under heat, by means of hydraulic presses. Generally, about 2,000 pounds are brought to bear, and the presses are connected with steam so as to secure the desired heat.

ODD METHOD OF VULCANIZING RUBBER BELTS.

An odd method is employed to vulcanize rubber belts. A stretcher is used to take the stretch out of the belts. This is made up of two sets of heavy clamps, and a great hydraulic ram which exerts a pressure of 2,000 pounds to the square inch. In this manufacture, the belting has already been made by pressing the rubber into the cotton duck. This is now cut into strips of desired length, and the strips are laid, one over the other, until the thickness of the desired belt is obtained. Then a strip of thin, pure rubber is wrapped about the several folds. The whole belt may then be put into a steam press and vulcanized.

RUBBER HOSE.

When rubber hose is made, a rubber tube is first slipped over a mandrill, and cotton-duck stripping is wrapped about it until the desired thickness is attained. Then, a thin sheet of rubber is rolled about it all. This is covered with strips and sent to the vulcanizing press. The press consists principally of an iron pipe which is thrust into the hose. Steam is admitted to the pipe and the hose is heated. When the process is over, compressed air is blown between the hose and the pipe to remove it. Firemen's hose, with its cotton outside, is made by drawing a rubber tube within the cotton tubing, and then the whole is charged with steam.

RUBBER TREE IN U. S. BARRACKS. KEY WEST. OVER 100 YEARS OLD.

HOW PIANOS ARE MADE

The most popular musical instrument to-day is the piano. Not many years ago it came under the head luxury, but the increasing culture and education of the people have changed all this and made the piano an every day necessity. Ten years ago there were manufactured in this country considerably less than 100,000 pianos. Last census year there were manufactured 374,154. These figures tell the whole story.

With the rapid development of the refining influences of life has come a demand for soulful music. The young girl's education is hardly considered complete without, at least, a moderate knowledge of the piano.

With such a demand there has come the supply, and the strife of competition has resulted in various improvements in the manufacture of pianos that have kept the art of the builder thoroughly up to date. The old square piano has been almost entirely superseded during the past 15 or 20 years by the upright, and tonal qualities have been so vastly improved that the cheapest piano, to-day, would rank well with the best of 20 years ago. By the introduction of a better quality of feet in the hammer, by the use of a large hammer and the production of a better wire, the musical quality of the piano tone has been improved even as it has been given greater volume.

Courtesy of the Starck Piano Co.

ACTION REGULATORS AT WORK.

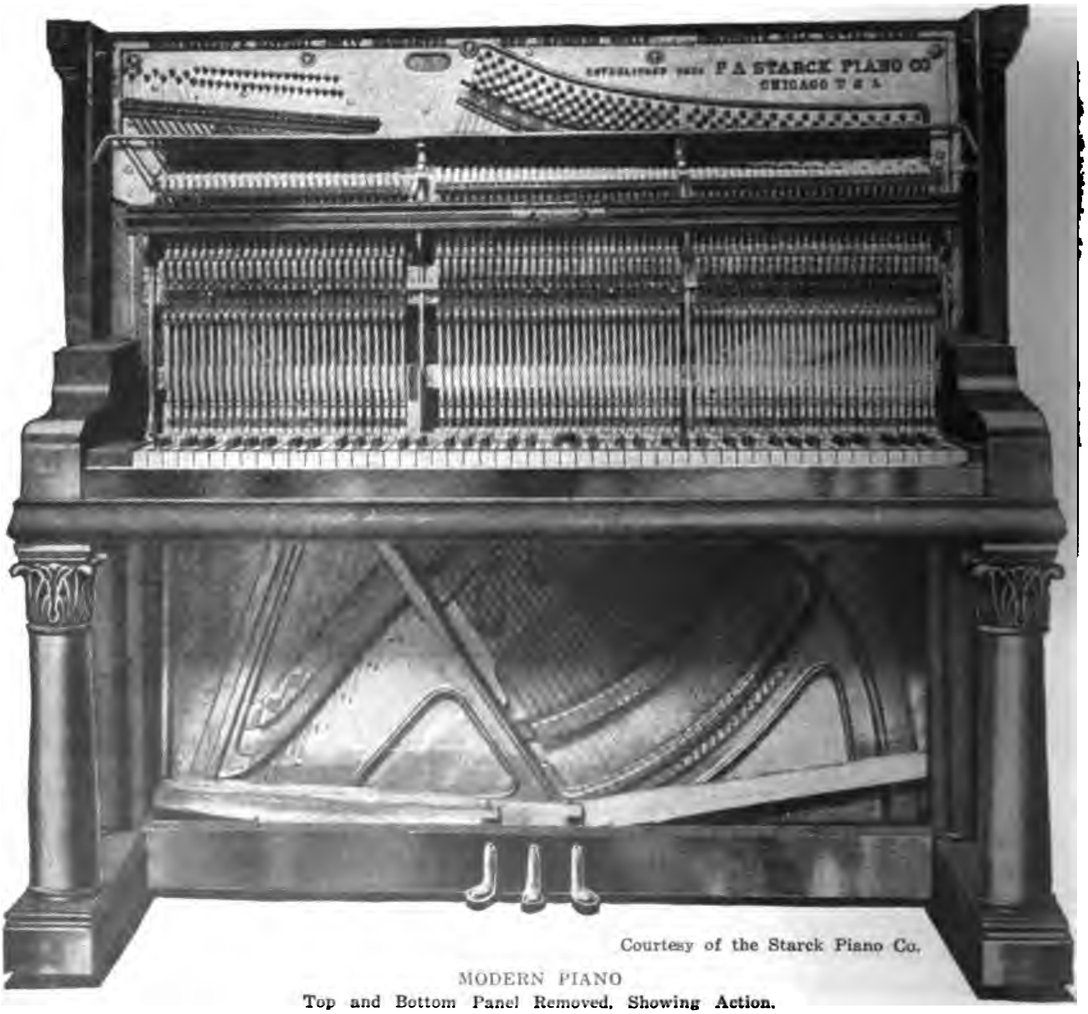
Courtesy of the Starck Piano Co.

SCENE IN STRINGING ROOM.

In order to bring the piano up to its present-day artistic worth, innumerable inventions have been patented, each ambitious manufacturer being constantly on the alert to devise a remedy for any suggested imperfection. One of the latest important inventions relates to the keyboard, and in an exceedingly simple way makes such a thing as a "sticking key" an impossibility. This new keyboard does away with all that difficulty, and by giving a firm, elastic touch, enables the performer to produce a more musical tone. Among piano manufacturers this keyboard is considered one of the most marked improvements of late years.

HISTORY OF THE PIANO.

The name pianoforte comes from two Italian words meaning *soft* and *loud,* and is accurately descriptive of the piano because the notes can at will be made soft or loud. The piano is a development of the simplest form of making regular sound vibrations by snapping or hammering a string of some kind which is stretched tight and fastened at both ends. We must go far back into history to find the earliest traces of stringed instruments, and even then we do not know where and when they originated, for there seem to be no records which help us to trace their origin. We know that the Egyptians as far back as 525 B. C. had stringed instruments, but we only know they had them—not where they got them or who made them.



Courtesy of the Starck Piano Co.

MODERN PIANO
Top and Bottom Panel Removed, Showing Action.

MAKING LEAD PENCILS

COMPOSITION OF THE LEADS.

The “leads” of lead pencils are made of mixture of German pipe clay and “black ead”, which is not lead, but graphite. But he first pencils were made of real lead and he name has clung to “lead” pencils ever since. Graphite, or plumbago, is a nearly pure form of carbon and most of the pencils made in this country use the graphite mined at Ticonderoga, Vermont, where the only graphite mine of any consequence in the United States is located.

SORTING OUT GRAPHITE PLUMBAGO
For making Lead Pencils.

GRAPHITE.

The graphite is taken in the lump from the mines and carried to the reducing mill, where it is ground or pulverized in stamp mills under water. The fine particles of graphite float away with the water through a number of tanks, collecting at the bottom of these reservoirs. It is packed in barrels in the form of dust and sent to the factory, where tens of thousands of lead pencils are turned out every day.

The pulverized graphite is so fine that it really is dust; it is dingy in color, and smooth and oily to the touch. It is divided into various grades of fineness by floating it on water from one tank to another. The coarse dust sinks to the bottom of the first tank, the next finer, to the bottom of the next and so on down the line, the finest powder, for the finest pencils, settling in the last tank.

GERMAN PIPE CLAY.

In another series of tanks the German pipe clay, which is mixed with graphite to secure the different grades of hardness, is graded in the same manner by floating. The finest clay is mixed with the finest graphite, and the hardness of the pencil is secured by increasing the proportion of clay in the mixture. For medium grades seven parts, by weight, of clay are mixed with ten parts of graphite.

PROCESS OF MIXING.

The mixing is done under a grinding mill similar to that used in mixing paint, and water is added to facilitate the mixing. The grinding stones are about two feet in diameter and only the upper one revolves. After the graphite and clay are ground together the mixture is put into canvas bags and the water is squeezed out under hydraulic press, leaving the mass the consistency of putty. This plastic material is placed in the forming press, which is a small iron cylinder in which a solid plunger or piston works up and down. A steel plate having a hole the size and shape of the "lead," is put under the open end of the cullender, and the plunger, pressing down, forces the graphite through the hole, making a continuous thread or wire of graphite.

As long as this thread is moist it is pliable, but it becomes brittle when dry, so it is handled rapidly. It is cut in three-lead lengths, straightened out, and then hardened in a crucible over a coal fire. The leads when taken from the crucible are ready for the wood.

DIFFERENT KINDS OF WOOD FOR PENCILS.

Pine is used for cheap pencils, an ordinary quality of red cedar is used for better pencils, and nothing but Florida Key cedar is used in the best.

CUTTING CEDAR STRIPS.

The sawmills at Tampa, Florida, cut the cedar blocks about seven inches long, and these are sawed into strips wide enough for six pencils; but as pencils are made in halves, each strip is thick enough only for a half pencil. When these strips are received in the factory they are run through a machine which cuts in each one six grooves, round or square, and at the same time smooths the face of the wood.

FILLING THE STRIPS WITH LEAD.

The filling of the strips is done by girls. The first one takes a grooved strip of wood in her left hand and a bunch of leads in her right. She spreads the leads out fan shape, and with one motion fills the six grooves with leads. Next to her sits another girl who takes the filled strip, and quickly and neatly lays on it another grooved strip, which has just been given a coat of glue by a third girl.

THE FINISHING PROCESS.

The filled and glued strips are piled up and put in a press to dry. The ends of the strips are evened off under a sandpaper wheel, and then the strips are fed into a machine which cuts out the individual pencils, shapes them and delivers them smooth and ready for the color polish in six streams. The coloring is done in liquid dyes, after the pencils have been sent through the varnish machine. Then follows the stamping, finishing and counting. This latter work is done by quickly filling a board having 144 holes in it, thus counting out a gross of pencils.

ARTIFI

In this day of progress, when everything in nature is being reproduced by man, it is little wonder that the demand for ice has resulted in the discovery of methods of manufacturing it. While the natural ice crop is still depended upon for the greater portion of the civilized world's supply, yet so far have the devices for making been perfected that artificial ice now a strong competitor of the natu product in all large cities.

MAK

But of even greater value than the su ply of man-made ice for domestic use of absorption of the heat in the surrounding atmosphere. This is done in a number of ways. In making liquid air, which is the coldest substance known, the process consists in making use of the law of nature which insists that compressing a gas warms it and then liberating it quickly cools it. Thus air is compressed and all the surplus warmth taken from it by spraying the pipes which contain it with cold water. Then when this cool and compressed air is liberated it expands with such rapidity that the warmth in the surrounding atmosphere is absorbed and a great cold is produced. This same principle is applied in a little different manner in the practical use of ammonia in making ice for commercial use.

WARMTH TAKEN FROM THE WATER.

The idea is that anhydrous ammonia. which freezes at 32 degrees Fahrenheit—so cold is it—upon being brought in contact with water, will take from the water its warmth.

THE CAN SYSTEM.

The ammonia method is the one most universally in use both in making cakes of ice and in keeping down the temperatures of cold storage warehouses. One method for using ammonia is called the can system. In its use, water in cans the size of the cakes of ice to be manufactured, is exposed to the ammonia circulating through coils of pipe laid in a tank of salt water. The ammonia absorbs the heat from the salt water and the salt water in turns freezes the water in the cans by absorbing its heat. Where storage rooms are to be cooled with making ice, the ammonia is pumped through pipes which run about the rooms and thus absorb the warmth in the air at first hand. In this process the air around the pipes, of course, is the coldest in the room. Thus the moisture that may be contained in the air nearest the pipes will be precipitated on the outside of the ammonia pipes in the form of thick snow ice.

ICE MADE FOR 50 CENTS PER TON.

One of the most efficient methods for ice manufacture is called the Holden system. By its use ice can be made for 50 cents a ton in a very small plant as against a cost by the can system of nearly $2 a ton.

THE PLANT NECESSARY.

The plant necessary in this system consists of a device for circulating the ammonia without loss and the ice machine. The former consists of three vertical pipes, 12 inches in diameter, and 40 feet high. These are called the still, the absorber and the condenser. Besides these there are two shorter pipes called the interchanger and the cooler, while an ammonia pump furnishes the power for circulating the ammonia.

PROCESS OF MAKING ANHYDROUS AMMONIA.

Strong ammonia liquor of 32 degrees Bane intensity, is pumped through the interchanger to the stop of the still. In the interchanger, it is practically heated. In the still, which is a device full of pipes which break up the ammonia into small drops, the ammonia is heated by steam and allowed to trickle down, giving off, the while, a strong ammonia gas. This gas passes out to the top of the absorber which is filled with pipes carrying circulating water. Here the gas is converted into anhydrous ammonia of exceedingly low temperature, and is ready to pass to the ice machine to do its work in the making of ice.

THE ICE MACHINE AND ITS OPERATION.

The ice machine consists of a hollow cylinder, revolving in a tank of water. The anhydrous gas passing into this cylinder creates a very low temperature, which at once takes up the heat that is in the tank of water. All the time the cylinder is revolving a thin film of ammonia clings to its inside walls. On the outside the water changes to a coating of ice. This is removed by knives which scrape off the ice in the form of spawls, which rise to the top of the water in the tank, and as they accumulate are conveyed by a screw propeller to presses so arranged that the water and air carried to them with the spawls are squeezed out, thus leaving blocks of ice clear and solid as crystal.

HOW CHOCOLATE IS MADE

Chocolate making has become one of the great industries of America. When, one day, shortly after the fall of his kingdom, Montezuma raised a golden cup to his lips, for refreshment, he introduced a new drink to the world, and that beverage was chocolate.

COCOA TREE.

CONQUERORS CARRY THE DARK-BOWN NUT HOME TO SPAIN.

Bernard Diaz, one of the Spanish officers with Cortez, observed the monarch, and in the history he afterward wrote of the conquest of Mexico, he described the king's act and its effect. Thus it came about that when the Spaniards took ship for Cadiz, they bore with them not only a yellow metal but a dark-brown nut from which chocolate was made.

KNOWLEDGE OF CHOCOLATE MAKING SPREADS THROUGH EUROPE.

This knowledge of chocolate making by the Spaniards was kept a secret for many years, but it finally crossed the Pyrenees into France, and spread throughout Europe. The manner in which the fame of the beverage was diffused is interesting. In the refectories of the Spanish monasteries chocolate had become such a favorite beverage that the monks, wishing to remember their brothers in France in an especially friendly way, sent them presents of the cocoa beans.

PURITANS BRING IT TO MASSACHUSETTS BAY.

Thus it was that when the daughter of Philip III. went to Paris as the wife of

Louis XIII., she bore with her from Madrid the news of the new drink from America. Next the Puritans took it with them to Massachusetts Bay. Since then, chocolate has become a household word in the length and breadth of the United States.

FIRST CHOCOLATE MILL IN AMERICA —1765.

The first chocolate mill was established at Dorchester, Massachusetts, in 1765. This mill, 15 years later, became the property of Dr. James Baker. Later, the establishment passed into the control of Walter Baker. Others afterward succeeded both Bakers, and a man named Pierce, in this concern.

STATISTICS OF MANUFACTURE.

In 1860 there were consumed in the United States 1,181,054 pounds of chocolate and cocoa. In the last census year there were 27 establishments manufacturing cocoa products, the value of their output was $22,390,222. The demand was rapidly increasing, the value of the output having increased five-fold since the preceding census.

CHOCOLATE MILL AT MILTON, MASSACHUSETTS.

To drive down the hill from Milton, Massachusetts, past the chocolate mills, is to inhale deep aromatic odors, that lead you to imagine that you are skirting the domains of "Araby the Blest." Within the mills there is a "spick" and "spanness" that make the aroma even more delicious, for they seem to fill it with a fresh and wholesome cleanliness. The whole theory of the process in the mills is that the cocoa bean is a product of nature, and that what it needs is refining and purifying, just as gold needs refining to be brought to the pure ingot.

THE COCOA TREE AND NUTS.

Chocolate is obtained from the cocoa tree, a tropical plant which reaches a height of between 20 and 30 feet. It bears pods about nine inches long, within which are closely packed the beans. These are about the size and shape of almonds, and of a brownish color, when dried. They come to market in burlap bags, and on the lower floors of the great mills, the first step in purification is taken by cleansing the beans from any dust or foreign particles that may have become attached to the shells.

THE PROCESS OF MANUFACTURE.

Next comes the roasting, a most important operation, upon which depends to a great extent the flavor of the beans. Too little roasting leaves them crude and underflavored, while too much tends to make them bitter. This process is carried on in the upper stories of the mills, the cleansed seeds being put into large cylindrical roasters, holding a ton each. These machines keep the seeds in constant motion over hot pipes, for about three hours. When they are "done to a turn" they are dropped through big hoppers to the floor below; there they are broken into small fragments. The shells, already loosened by the roasting process, are then removed by ingenious winnowing machines, where the bean fragments are fanned within screens, and the light shells neatly separated from the solid fragments of the beans.

COCOA SHELLS.

The manipulation of these winnowing machines requires experience and care, for a workman may easily blow away his salary by admitting too much current to the fans. These shells, once separated, are ready to be acked in boxes and placed on the market. ocoa shells are well-known and widely sed, making a palatable and inexpensive rink, with a slight flavor of chocolate bout it.

GRINDING THE CRACKED COCOA.

The cracked cocoa, freed from the shells, is now destined to be turned into chocolate without further ado. This is accomplished by a process of grinding. From the winnowing floor the cleaned fragments drop another story, again through capacious hoppers, down to the great grinding rooms. Stretching away in seemingly endless ranks, stand big, gleaming, intricate machines, which receive the cocoa beans as they are fed into the hoppers above, and grind them into a fine, smooth paste or thick liquid.

MOLDING THE CAKES.

As this liquid flows thickly out at the bottom of the burnished grinder, it falls, if it is to be a plain chocolate, into oblong molds, which give it the form familiar to housekeepers. It is now in the molds, but not yet molded. For that purpose, it must be carried into a room which seems to be nothing but noise. This is the room of the automatic molders. If the chocolate were pressed into the molds, it would merely stick to the presser mold and all; so, instead, it is shaken in. The pasty lump of chocolate in its metal mold is put into a wooden tray on a table, which is shaken by steam, and makes the molds bob up and down in a most deafening manner. After the chocolate is fitted to the mold, it is carried off to the cooling rooms.

SWEETENING AND FLAVORING.

In making sweetened chocolate, pure sugar is added in a certain proportion, before molding, and also the finest quality of vanilla beans, if it is to be vanilla chocolate. In the manufacture of breakfast cocoa, a portion of the oil of the chocolate bean is removed by hydraulic pressure, and the pressed mass remaining is ground into minute particles. This process is continued until a high degree of fineness has been obtained.

HOW GOLD LEAF IS MADE

A large amount of gold leaf is used in the arts, as in stamping and gilding books. The process of manufacture is most interesting. The preliminary preparation consists in rolling the gold into long ribbons about as thick as ordinary paper and an inch in width. This is cut into little squares and is then ready for the first beating.

This is done with a sixteen-pound hammer. Two hundred pieces of sheet gold are placed between sheets of oiled paper, used exclusively for the purpose, the sheets being held together by two parchment bands. This forms a package three and a half inches square and about three-quarters of an inch thick, known as a cutch. This is then placed on a marble anvil sunk three feet in the ground and is there hammered with the sixteen-pound hammer, this causing the gold to flatten and spread out between the sheets of oiled paper. When all the pieces have been spread out evenly to the edges of the cutch they are taken out and each square is cut into four smaller squares.

The 800 pieces thus formed are placed in a package of oiled paper four and a half inches square called a shoder. This is hammered with a twelve-pound hammer until the gold is driven beyond all four edges, the gold extending over the edges, known as scruf being scraped off with a knife and saved to be remelted. The 800 large squares are then removed from between the oiled paper, placed, one at a time, on a leather cushion and cut into four smaller squares. The 3,200 leaves thus formed are placed in three packages of skins called moles.

These skins are obtained from the intestines of cattle, only one portion being suitable for the purpose, the size of which is barely sufficient to make one skin. Each mole or package of skins will therefore represent over 1,000 head of cattle. Gold-beater's skins are now furnished exclusively by a London firm, which prepares them by a special process that has been carefully guarded and kept a family secret for many generations. In Chicago the fresh skins are obtained from the stockyards and are then sent to the English firm, where they undergo the secret process, after which they are shipped back.

GOLD BEATER'S TOOLS.

These skins serve in the same way as the oiled papers in the former operations, but are much smoother and present very little friction to the spreading gold. The moles are beaten on the marble anvil in the same manner as the cutch and shoder, except that two hammers are used. The first beating is done with a six-pound hammer and is continued for two hours, after which the beating is continued with a ten-pound hammer two hours longer.

The gold beater examines the work from time to time by slipping off the parchment bands and turning over the edges of the skins, thus showing where the gold is spreading the least and enabling him to determine where to strike the greater number of blows.

Before each beating the skins have to be carefully prepared by the gold-beater. They must be neither too hot nor too cold; must have just the right amount of moisture, and require more skill in their preparation than any other branch of the art.

If properly used and cared for, one package of skins will give constant service for about a year and a half, but if given a single foul blow, i. e., struck with the edge of the hammer, the whole pack will be ruined. Overheating will also damage the skins, and if carried too far will spoil them entirely.

The extreme thinness of gold leaf, 1 200,000 to 1 250,000 of an inch, makes it transparent to light, a single leaf, held between the eye and the light, having the appearance of green glass or very fine green gauze, and all objects appear to have a green or when viewed through a piece of gold f the same as when a piece of green glass held to the eye.

After the final beating the gold leaf is trimmed into three and three-eighths inch squares, which is the universal standard in all countries, and it is then packed in books ready for the market.

HOW OPIUM IS MADE

While opium has done much to alleviate e pains of humanity, it has also put into dreamy stupor many a devotee of its in-dious fumes. In international affairs, owever, it has had a far different effect, or it has caused the shedding of English, rench and Chinese blood in battle, and he diplomats of these three countries have sed all of their skill in settling questions hich have been raised over it.

A PROBLEM IN THE POLITICS OF EASTERN ASIA.

For many years opium has constituted a problem in the politics of Eastern Asia, in connection with the collection of taxes. In French Indo-China, it has long been contended that this drug is the chief cause of the difficulties with the native races, and that the famous pirates on whom the French made war were simply honest merchants, whose affairs were interfered with by the opium monopoly.

Upon Great Britain is charged the responsibility of the war between her and China, 40 years ago. It is claimed that the desire of the British to establish a monopoly of the opium trade brought on the hostilities, which ended in opium becoming the curse of the Chinese empire.

THE POPPY.

Opium comes from the poppy, many of which flowers flourish in our own gardens. Soil and climate have a great influence on the chemical qualities of the various kinds of it which are found in Persia, China, and, more especially, in India, where for many years the English government has monopolized its culture, as in France, the government monopolizes the culture of tobacco.

PRODUCTION OF THE POPPY IN THE REGION OF THE GANGES.

In all the immense and fertile valleys of the Ganges, nothing is asked of the earth except the poppy. Patna and Benares are distinguished by the richness and abundance of their harvests. The product of this cuture in the province of Bengal, alone, is estimated at 15,400,000 pounds, which represents a value of nearly $30,000,000.

EXTRACTION OF RAW OPIUM.

Opium is extracted from the matter which exudes from the green, unripened capsule of the poppy. This matter is gathered in little globular particles, of amber color, by means of a special instrument. It is then put into small earthen pots, which are carefully covered, and then transported to the laboratories of the English government, where it is made into balls about the size of "Dutch" cheese. These are covered by petals taken from the plant. After they have been dried, they are shipped to Calcutta, the market which supplies all Asia.

THE FINISHED PRODUCT.

From this raw opium is made the finished product which is used by the smokers. The process is a most delicate one and one from which only the Chinese know how to get the best results. From Calcutta the opium is brought to the opium boiling establishments. An ordinary "boiling" place usually contains four or five large boilers, and from 150 to 175 small furnaces, each having a basin constructed of masonry, and all ranged along in the form of a long bench.

BOILING THE OPIUM BALLS.

Immediately upon the receipt of a shipment of the raw opium balls they are cut in half, the raw material being drawn out with the fingers. That part which remains attached to the envelope or covering, is afterward secured by placing it in boiling water. When these preparations have been completed, the opium is placed in the basins with the water, where it is boiled for two hours and constantly stirred until it reaches the necessary consistency, which nothing but long practice can determine. The opium worker seats himself on the ground, and with the aid of a small instrument, works and kneads the mass before him, over and over.

After a time the mass of opium is spread over the surface of the basin, which is tilted so that the direct heat of the fire is radiated against it. Under this influence, the external surface of the opium loses part of its moisture, and then becomes softer. Then the basin is taken from the fire, and the cold air operating on the surface of the mass hardens it suddenly, while the part below retains its paste-like consistency.

Then it is that the worker seizes the hardened crust and detaches it from the rest of the mass. Then, again, the basin is exposed to the fire, followed by the removal of a second, and sometimes a third, crust, which is later broken and placed in basins of water. After 24 hours, all the solid parts of the opium become separated, and the liquor is filtered and evaporated at the fire to a suitable consistency. The extract is then put into copper vessels and left to undergo fermentation, which removes from it all the acrid principles and permits it to acquire all of its necessary properties.

THE COMPLETED PRODUCT.

In its completed state, the opium presents itself in a cake, brown in color, like molasses, and exhaling an aroma difficult to describe.

HOW MUSIC IS PRINTED

Millions sing popular songs, but few know what a page of music represents. Just to give an idea of the subject, it may be put down in the outset that an ordinary piece, of three sheets, selling for 10 cents, involves the use of more than 5,000 separate types.

Chicago is one of the great music publishing centers of the country, and its daily output ranges through all the grades of vocal and instrumental literature—from the symphony for a full orchestra, reproduced for the first time from the manuscript of the Chicago composer, to the cheapest reprint of the newest thing in concert hall music.

WOMAN IN MUSIC PRINTING.

Woman is on an equality with man in this department of the publishing trade. She commands a man's wages for "composition," and, as the work is of the most elicate and perplexing kind, her patience nd dexterity usually give her a marked uperiority over the men of the guild.

DIFFERENT METHODS IN PRINTING.

A composer with a piece of music to pubish has his choice among four kinds of printing. If he is rich, he may have the score engraved on copper and printed as if it were an expensive picture, or he may have it stamped in zinc, or it may be lithographed. But if he is bent on money-making and celebrity, he will go to the musical type-setter.

THE MUSIC PRINTER'S CASE.

The case of the music printer is divided into 700 boxes, one for each character, and the compositor must have learned her case perfectly or she will be able to make poor headway with her work. First, she sets the character for the clef, and the end of the staff. Then she inserts the sharps or flats of the signature, and spaces out the staff with short pieces of brass rule. Next, she pieces to get her figures and staff rules to indicate the time.

THE NOTES.

Suppose the first note of the piece of music is a quarter-note in the second space, with a sharp before it. The compositor puts in the sharp first and fills up the space with bits of brass rule to continue the staff; then she inserts the body of the quarter-note with two lines below, and above it puts the two types necessary to make the stem of the note, and to keep the staff unbroken. Sometimes five more separate types must be inserted. A measure of eight consecutive notes, three-four time and a tenor clef indicated, seem to contain ten characters. As a matter of fact, the number is 78, at the very least, and more if the measure has accidentals or complicated harmony. It takes about five years for an apprentice to learn the trade. It is not necessary to have musicians to set music type, yet in correcting proof it is the aim of the typesetters to know enough music to avoid errors.

MUSIC TYPE.

On this side of the Atlantic music type is made only in Philadelphia, and so great is its cost that it is never put to the wear and tear of the presses. As soon as the proof is corrected by the proofreader, the form of type is molded in wax and then an electrotype is cast from this matrix. After that comes the tedious work of distributing the several thousand types, for the wax sticks in between and makes the sorting of the type difficult.

LITHOGRAPHIC PROCESS OF EGRAVING FOR MUSIC.

Next in importance is the lithographic process of engraving for music. A plate of zinc is ruled off with the series of five lines of the staff. Then the music is copied in reverse on the zinc, and the engraver, with many separate dies and punches, stamps in the notes, bars and rests. When this is done and the plate is hammered straight, it is filled up with thick transfer ink. An etcher's proof is taken of this, and while the ink is yet wet, it is pressed upon a lithograph stone. From this point the work of printing is the same as that of a one-color lithograph, that is, the stone is kept wet and the ink adheres only to the characters of the music.

Sometimes, to avoid expense in printing small batches, music is printed direct from the stamped zinc sheets. In this case beeswax is filled into the lines and dots for some depth, as otherwise there would be so much ink taken up by the indentations that the sheet music would be blurred.

THE PROCESS OF PRINTING.

In printing the music, dampened paper is used. In the press, a heavy bed of iron supports the engraved plates with paper on them. By means of a big capstan wheel, this bed is moved in between two iron cylinders moving in the same direction. A heavy blanket of felt is wrapped about the upper roller, and the pressure causes the ink in the plate to be sucked up on the paper. These presses must be run by hand, and the plate inked and wiped off for each impression. Thus the cost of printing is about half a cent a sheet.

HOW LEATHER IS MADE

In general, all know that leather is the prepared skins of animals. The word pelt properly means animal skins before they have been converted into leather; hide is the name generally applied to skins of large animals, like horses and cattle; skins are the lighter forms of leather from sheep, goats, etc., and especially fur-bearing animals in which the hair is retained. The inner layer of all pelts is known as the corium and is composed of gelatinous fibers. A pelt left untreated will decay. If dried, it becomes stiff and boardlike.

Tanning consists in applying to a pelt certain substances and treating it in certain ways so that it is converted into a durable substance, porous and flexible. It is then known by the general term of leather, which, of course, differs in some respects according to the pelt from which it was made, whether from horse, cow, sheep or other animal, also they differ according to the method of tanning employed, as oak tanned and so on. The active principle in all the older forms of tanning—and which gives its name to all processes—is tannic acid, which is derived from the bark of certain trees, as oak, hemlock, etc.; from certain shrubs, as the sumac, and from other vegetable growths. The astringent taste in tea is due to tannic acid. But the same result can be secured by the use of chemicals, and in this case the leather is produced much quicker than in tanning proper. Skins can also be rendered durable, flexible, etc., by a simple process of rubbing with alum or salt, etc. The proper name for this process is tawing.

The first step in producing leather is to remove the hair; the name of all such processes is depilation. One way is known as sweating. The hides are hung up until slight decay sets in, when the hairs are removed by a kind of combing. Another is known as the liming process, in which some solution of lime is used to loosen the roots of the hair. The hides are then laid in deep vats in layers, between which are layers of ground bark from hemlock or other trees, rich in tannic acid. The vat is then flooded with water and the hides soak for a long time, until the chemical change effected in the corium by the tannic acid has taken place. The crude leather is then treated in various ways, dressed with oil, perhaps one side colored, or grained by machinery, or some hides are split by a machine so as to produce thin leather.

The uses of leather are innumerable. The principal one that occurs to all is the manufacture of boots and shoes. In the last census year the value of the leather manufactured in the United States was $327,874,000.

But large quantities of leather were imported. The value of boots and shoes manufactured was $512,798,000, and other leather goods to the value of $104,710,000.

LEATHER MANUFACTURE.

In the last census year there were 910 establishments employing 62,202 workmen. The number of establishments was decreased, but the number of workmen and the value of the leather manufactured has steadily increased. This shows the tendency of all industries to concentrate. The total number of skins tanned was 33,665,000. This includes all animals. Cattle, including calves, furnished the largest number, sheep and lambs the next in order. The fur, in larger proportions, came from slaughter houses, but over 3,000,000 came from farms. In addition to these supplies very large numbers of undressed hides were imported, coming principally from South America.

In addition to boots and shoes, a great deal of leather is used in the manufacture of gloves and mittens. Over 10,000,000 dozen pairs were made in the last census year. Other uses for leather is the manufacture of saddles and harnesses and carriage goods. In the last census year $21,000,000 of such goods were produced. Trunks and valises come next and $8,547,000 worth were manufactured. Finally, to give completeness to this review, $1,700,000 worth of pocketbooks were made, and even razor strops, suspenders and small articles require large amounts of leather, as $8,547,000 of these articles were made.

HOW PAPER IS MADE

Paper can be made from any vegetable fiber, and also from silk or wool, but these are not desirable paper stock. Formerly, all paper was made from cotton and linen rags, but of late years wood has been used for cheaper grades of paper, especially for newspaper work. This demand is destroying our forests at a rapid rate. In 1914, 4,330,000 cords of wood were used in the paper trade. Spruce is the principal wood used, though others are also employed. Wood pulp is made by grinding the wood on rapidly revolving grindstones, operated by steam or water power. Wood fiber is made by digesting short pieces of wood in boilers containing a dilute solution of sulphuric acid at a high temperature. The pulp and fiber are mixed to make paper.

The other materials from which paper is made—rags, straw, cornstalks, etc.—are reduced to a pulp, the rags being first cleaned from dirt, buttons cut off, etc. The machines that make the pulp are known as grinders. They consist of knives fastened to revolving cylinders, playing between smaller knives in the bottom of an oval tank.

The paper from all kinds of pulp is made in a machine known as the Fourdrenier machine. It consists of three sections. In the first, the pulp is allowed to pass out on an endless, traveling wire cloth, 60 or 90 meshes to the inch. The water in the pulp drains rapidly away and the solid matter arranges itself in a thin layer which by further processes of passing between rolls becomes a sheet of paper. The finished paper varies in several ways, first, according to the material used. Linen paper and wood paper are very different articles. The first is high-grade letter or book paper, the second is used in newspapers. Common wrapping paper is made from straw, better grades from other material. Papers also differ according to the finish put on its surface by the rolls or calenders, and is known as machine finished or calendered paper. A sizing is often used on the latter paper—on the same principle that we use starch on laundered clothes—to give it a glossy surface. India paper is a very thin but strong paper often used in books, especially in fine grade teachers' Bibles.

MIXING ROOM.

The wood fiber must be mixed with other ingredients when paper is made from it. This shows a corner of the large electro-chemical department for the production of bleach and soda used in the preparation of rag and wood fibers.

We have only to consider the immense number of books, papers, and periodicals published to realize that a vast amount of paper must be manufactured in the United States to supply our needs. In the last census year, the value of paper and wood pulp produced was $267,657,000.

PAPIER-MACHE.

The discovery of the process of making paper from wood has led to the use of paper for many purposes for which it could otherwise never have been used. The wood pulp is also used in the form of papier-mache, a tough, plastic substance, which is made by mixing glue with it, or by pressing together a number of layers of paper having glue between. Papier-mache can easily be molded into almost any form, and after drying forms a very tough substance and one that will stand rough usage. It has been employed for making dishes, water baskets and utensils of many other kinds, for making the matrices for electrotype plates.

HOW PATENTS ARE OBTAINED

The United States Patent Office issues tents under the seal of the government any person who has invented any new d useful art, contrivance, manufacture composition of matter, improvement, or e like, not already patented or known in is country, or not printed or described any publication, local or foreign, prior the discovery, and not on sale two years efore the application for the patent, unss such sale has been discontinued. Some f the ingenious inventions for which patnts are issued include busts, statues, reiefs, designs for printing fabrics, new rnaments, patterns or new shapes of artiles for manufacture.

PATENTS AND THEIR CONDITIONS.

The patent is an instrument granting to the patentee, his heirs or assigns, the exclusive right to his invention for a period of 17 years, within the jurisdiction of the United States. Joint patents are issued to two or more people who work on the same invention, and not single patents to each. Patents on foreign inventions for which foreign patents have been already allowed may be secured from this government, unless the article patented abroad has been in use here more than two years prior to the time of application. Patents thus secured, however, expire at the end of the foreign patent-term which has the least unexpired time, if there are several patents, and in no case run over 17 years.

APPLICATIONS FOR PATENTS.

The Commissioner of Patents is the official to whom applications for patents must be directed. With the application must be filed a written description of the invention, with its manner of making, construction, compounding, or the like, made perfectly clear. In case it is a machine a model must be sent. Drawings also are required for certain inventions. An oath is required of all applicants, stating that they believe the invention new and original and that the applicants are the rightful discoverers.

ASSIGNMENT OF PATENTS.

Assignments of patents may be made, or of an interest in a patent. This is done in writing, and the exclusive right to the patent for the whole or part of the United States may be thus granted. In case of errors, where more than rightful claims have been allowed to a patentee, the patent becomes invalid. But where papers are filed showing such errors, a re-issue will be granted.

CAVEATS.

A caveat is a notice filed with the Patent Office by an inventor stating that he is working on an idea and that he wishes to prevent a patent issuing to any one else who may have the same idea. This costs $10, and protects the caveator from infringement for one year.

PATENT FEES.

All patent fees are paid in advance and run as follows: Filing original application, $15. Designs, for three years and six months, $10; seven years, $15; 14 years, $30; each application for re-issue of patent, $30; filing disclaimer, $10; certified copies of patent, etc., ten cents a hundred words.

PATENT ATTORNEYS STUDYING THE RECORDS

dles the letters until the hour of closing at night. Whenever it is convenient or there is any chance of saving time, special delivery letters are sent out to substations, to be conveyed to their destinations from that point. At 4 o'clock the last dispatch to outlying stations is sent out. At 5 o'clock another leaves the postoffice for more centrally located points. Then between 5 and 6 o'clock the entire city is covered by messengers. After 6 o'clock the delivery boys cover seventy-five square miles, and at 9 o'clock the aggregate territory is reduced to twelve square miles. Between 6 and 11 p. m. there are but thirty-five messengers on duty, and on an ordinary night they handle 350 letters. On Saturday night the number is increased to about 500.

It makes no difference what the condition of the weather may be, these youngsters must deliver letters to any address as late as 11 o'clock. Within a radius of ten miles they are expected to use bicycles for transportation purposes, one of the requirements for entering the service being that a boy shall own a bicycle in good condition and a full uniform, costing $12.

DELIVER 1,000 LETTERS A DAY.

With more than 1,000 letters a day bearing special delivery stamps coming into the postoffice, it would be impossible to handle them if each boy were given but one on a trip. The result is that when a boy starts out he may have two, three or half a dozen letters to deliver and may make as much as 50 cents by traveling but a few blocks. But the aim of those in charge of the department is to make the earning capacity of one boy no greater than that of another, and they endeavor to regulate distances as best they can.

Most special delivery letters are carried on bicycles, but in cases of extremely severe or unpleasant weather the boys are furnished with money for car fare on lines which do not recognize the government's messengers to the extent of giving them free transportation privileges. Thus in an average day's work a boy will ride many miles on his bicycle, and also take several lengthy jaunts on steam or street cars.

The "first in first out" system is followed in the postoffice in sending out messengers. Each boy is supplied with a paddle bearing his number. When he comes in from a trip he surrenders this to the man in charge, and it is placed on the bottom of a pile representing the boys who are in ahead of him. As soon as there is a letter to deliver the clerk takes a paddle from the top and calls the number printed on it. In this way the trips are kept straight and no one boy has an advantage over another.

LESSONS IN SELF RELIANCE.

In this occupation as in every other, it all depends on the boy back of the letter what he is going to get out of his work, not necessarily in money but in habits of energy, thrift and self reliance. There boys are constantly gathering experience that may be of help to them in other work. There is also an element of danger to the boy himself. He is often sent to places where whatever experience he may gain is not for good. He may be exposed to all sorts of moral dangers. It depends on his own moral fiber whether he is to take on that which will harm him or whether he will resist the downward tendency of those with whom he is thrown in contact. His work will certainly afford him a large amount of experience that can be helpful to him.

HOW THEY FORETELL THE WEATHER

THE WEATHER BUREAU. SIGNAL STATION AT MOUNT WASHINGTON, NEW HAMPSHIRE.

Everybody knows the weather man. Nearly every community formerly depended upon some local prophet to foretell the weather. Predictions and traditions of all sorts were heeded, but little study was given to the weather from a scientific point of view. Even to-day the weather man is made the butt of the jokes of the fireside.

As a matter of fact, the weather bureau of the United States Department of Agriculture instead of being a joke, testifies to its efficiency by issuing more than ten thousand weather bulletins daily, not including the forecasts printed in the newspapers. While weather prognostication frequently goes awry, the science (for science it is) of meteorology not only deserves commendation in its present stage of development, but has shown itself acceptable even by the most skeptical.

A SCIENCE OF TENDENCIES.

This science is one of the tendencies. Where other sciences are based on actual and existing facts, the work of the weather bureau has to do with the probable developments of atmospheric phenomena. The weather man, equipped with rain gauges, weather vanes, gauges for calculating the speed of wind, and an intricate system of communication with other weather men throughout the country, makes it his business to register conditions of the weather and to deduce from them the kind of weather likely to prevail at a certain time in any given locality.

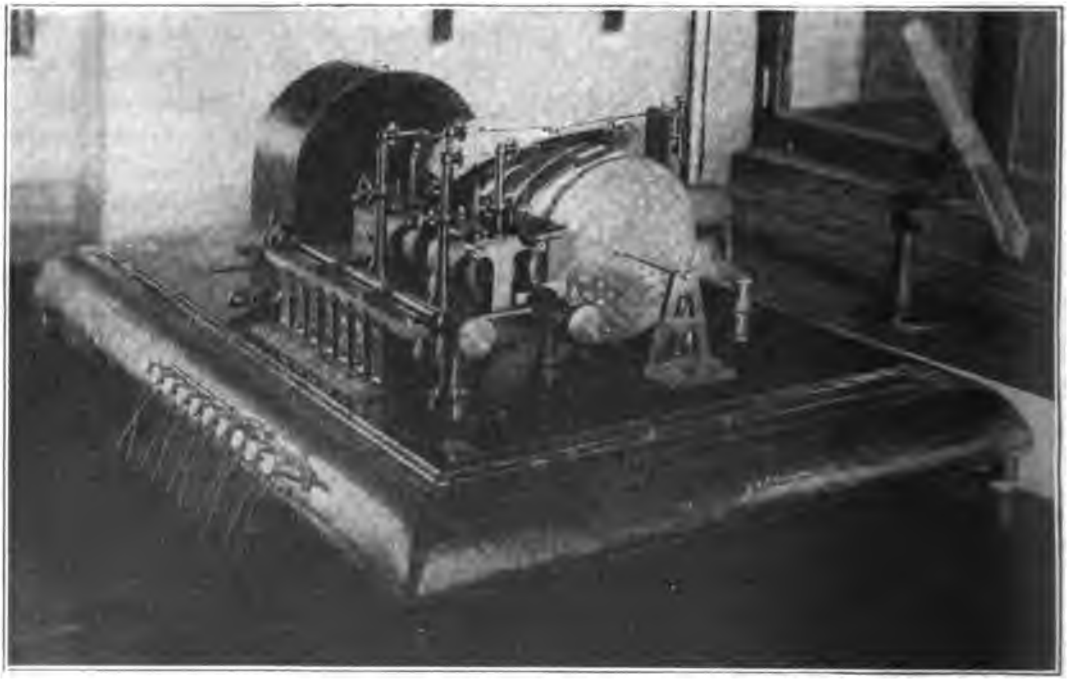
STORM CONDITIONS.

A storm may be brewing around Medicine Hat. The direction of the wind, the lowness of the barometer and other conditions may indicate clearly that the storm will slide down in a southeasterly direction and strike Chicago. Immediately the weather man from his eyrie, in the Auditorium tower, in Chicago, for instance, sends out messages over the whole Central West warning mariners on the great lakes, as well as farmers who have perishable crops, that a storm is approaching. From an apparently unknown cause, a "low" barometer is noted in Kansas. The storm suddenly veers in that direction, and the Chicago weather man once more is the subject of many jests.

Such conditions constantly arise and it is only by the most careful observation that tions made therefrom. As a matter of fact, however, so efficient has become this country-wide service, that some weather prognosticators have to their credit as many as nine out of ten correct predictions.

AREA COVERED BY THE SIGNAL SERVICE.

The area embraced in the weather bureau service extends from the Atlantic to the Pacific, from the north coast of South America northward to the extreme northern Canadian habitations. Records are carefully made of cold waves, hot waves and storms. Bulletins are sent on postal cards printed by postmasters, from telegraphic reports, to outlying towns, for display in suitable places.



Instrument at Weather Bureau, which records the direction and velocity of the wind, the sunlight and the rainfall on the same sheet of paper. A late invention.

SAVED YEARLY.

So complete is this service that every year millions of dollars' worth of property are effectually protected from damaging storms by timely signals.

At nearly every port there is either a complete weather observatory, or a storm-signal station where a system of danger lights is displayed at night or flags by day, warning the navigator of approaching storms. The shipping of the Atlantic seaboard is thus protected with greater certainty than that on any other American coast. One reason for this is that, except those from the Gulf, nearly all the storms which sweep the Atlantic coast, originate in the Mississippi Valley, and the service of the weather bureau shows that they reach